1988 Annual Air Quality Report for Prince George

Prepared for the

Prince George Ambient Air Technical Committee

Waste Management Branch

Ministry of Environment

Northern Region

Prince George, British Columbia

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Table of Contents

Page

Preface and Acknowledgements.....iii

1. Objective.....1

2. Air Quality Data for 1988.....2
   2.1 Gaseous Contaminants.....3
   2.2 Particulate.....11

3. Meteorological Information for 1988.....14
   3.1 Analysis of 1988 Data.....14
   3.2 Analysis of Wind.....16
   3.3 Meteorological Trends.....32

4. Emission Source Status.....34
   4.1 Changes to the Emission sources in 1988.....34
   4.2 SO2 Emission Source Changes in 1988.....35

5. Industry Shutdowns.....38
   5.1 Pulpmill Shutdown.....38
   5.2 Husky Oil Refinery Shutdowns.....38

6. Air Quality Trend Analysis.....39
   6.1 Total Reduced Sulphur.....39
   6.2 Sulphur Dioxide.....47
   6.3 Dustfall.....48
   6.4 Total Suspended.....51

7. Conclusions.....54
   7.1 Emission Source Status Change.....54
   7.2 Air Quality.....54
   7.3 Industry Shutdowns.....55
   7.4 Meteorological Conclusions.....56

8. Follow-up and Recommendations.....57
   8.1 Follow-up to 1987 Report.....57
   8.2 Recommendations.....58

9. Appendix

   B - Industry Shutdowns

   C - Emission Sources
   C-1 Description of Major Industrial Complexes
   C-2 Description of Point Emission Sources
   C-3 Typical Emission Rates from Industrial Complexes

Appendix - cont'd

D - Program Description
D -1 Instrument operating Hours
D -2 Ambient Air Analyzer Instrument Drifts and Malfunction
D -3 Instrument Changes
D -4 MIS Equipment Malfunctions

E - Maps
E-1 Air Monitoring Sites and Industrial Discharge Locations
E-2 Prince George Topographic Features

PREFACE AND ACKNOWLEDGEMENTS

This report fulfills a requirement by the Joint Government/Industry Committee for the Prince George Air Quality Study. The report presents a summary of the air quality and meteorological information including emission sources and the assessment of 1988 air quality and meteorological data.

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The report was prepared as a service to the joint Government/Industry Committee for the Prince George Air Quality Study which is comprised of representatives from the following:

Husky Oil Operations Ltd.
Intercontinental Pulp
Ministy Environment - Northern Region
Northwood Pulp and Timber
Prince George Pulp and Timber Ltd.

1. OBJECTIVE

The purpose of the current study undertaken by the joint Government/Industry Committee is to conduct an ambient air monitoring program in Prince George, to assess the air quality and to establish the relationship between air quality, source emissions, and meteorological conditions.

This report summarizes the factual data collected in 1988 describing the emission source status, air quality, and meteorological data and includes a trend analysis of air quality from 1980 to 1988. The appendix contains updated support information relating to emission sources, equipment and stations, industry shutdowns and maps.

2. AIR QUALITY DATA FOR 1988

In 1988, five air quality monitoring stations were in operation. Parameters monitored are listed below in Table 2.1. In addition, the sulphation index was monitored at three sites in close proximity to the pulpmills and oil refinery.

Changes to the data collection network are detailed in Appendix D.

Table 2.1
Prince George Air Quality Monitoring Program for 1988

Map Site No.	SEAM Site No.	Location	Parameters
1	0450325	Foreman Flats	DF,TSP,SI,TRS
2	0450322	Jail	TRS,SO2
3	0450307	Plaza 400	DF,TSP,SI,TRS
4	0450232	Van Bien	DF,TSP,SI,TRS
5	0450324	Lakewood	DF,TSP,SI,TRS
6	0450276	N. of Husky	SI
7	0450278	Old Fraser	SI
8	0450282	Northwood	SI

DF= Dustfall, TSP= Total Suspended Particulate, SI= Sulphation Index,

TRS= Total Reduced Sulphur Compounds (as H2S), SO2= Sulphur Dioxide

2.1 Gaseous Contaminants

Total Reduced Sulphur (TRS) Compounds

Table 2.2 lists:

(1) the number of hours that the Philips continuous TRS analyzers operated at each station in 1988 (one hour/day calibration cycle means that 96% would be continuous operation),

(2) the number of hours and percent of total actual operating time that the TRS (measured as H2S) hourly averages exceeded the Provincial hourly TRS objectives,

(3) and as a notation to the table, the Provincial TRS objectives.

Table 2.2
Summary of TRS (Measured as H2S) Data for 1988

Monitoring Stations	No. of Hours Instrument Operated in 1988	Number of Hours TRS Values	
		>7ug/m3	>28ug/m3
Foreman Flats	8134 (92.6%)	2328 (28.6%)	673 (8.3%)
Jail	8267 (94.1%)	2307 (27.9%)	1343(16.2%
Plaza 400	8297 (94.5%)	1633 (19.7%)	792 (9.5%)
Lakewood School	7462 (84.9%)	270 (3.6%)	38 (0.5%)
Van Bien School	8207 (93.4%)	1137 (13.9%)	353 (4.3%)

B.C. Ambient Air Quality Objectives	Level A	Level B
One Hour Avg.	7 ug/m^3	28 ug/m^3
24 Hour Avg	3 ug/m^3	6 ug/m^3

Seasonal Ambient Variations of TRS

The observed ambient TRS concentrations for all stations are presented by season in Table 2.3. In 1988, all five stations had similar seasonal trends in relation to TRS exceedences. All stations revealed TRS ambient air quality to be best in spring and summer and worst in the fall and winter.

Table 2.3
Seasonal Variations of TRS Data in 1988

Season*	No. Hours Instrument Operated Per Season	No. of Hours TRS Values Exceeded	
		7 ug/m^3	28 ug/m^3
Foreman Flats			
Winter	2075	727 (35%.0)	179 (8.6%)
Spring	2096	538 (25.7%)	133 (6.3%)
Summer	2100	539 (25.7%)	157 (7.5%)
Fall	1920	601 (31.3%)	207(10.8%)
Jail			
Winter	2072	683 (33.0%)	395(19.1%)
Spring	2081	462 (22.2%)	274(13.2%)
Summer	2029	350 (17.2%)	160 (7.9%)
Fall	2083	732 (35.1%)	453(21.7%)
Plaza 400			
Winter	2075	423 (20.4%)	218(10.5%)
Spring	2094	344 (16.4%)	164 (7.8%)
Summer	2074	230 (11.1%)	100 (4.8%)
Fall	2052	522 (25.4%)	257(12.5%)

Table 2.3
Seasonal Variations of TRS Data in 1988 (cont'd)

Season*	No. Hours Instrument Operated Per Season	No. of Hours TRS Values Exceeded 7 ug/m^3	28 ug/m^3
Lakewood Junior Secondary School			
Winter	1885	92 (4.9%)	11 (0.6%)
Spring	1541	27 (1.8%)	7 (0.5%)
Summer	2013	19 (0.9%)	6 (0.3%)
Fall	2039	101 (5.0%)	11 (0.5%)
Van Bien Elementary School			
Winter	2062	420 (20.4%)	134 (6.5%)
Spring	2059	214 (10.4%)	61 (3.0%)
Summer	2096	108 (5.1%)	20 (1.0%)
Fall	1997	313 (15.7%)	96 (4.8%)

*Winter; December. 1987, January 1988, February
Spring; March, April, May
Summer; June, July, August
Fall; September, October, November

B.C. Ambient Air Quality Objectives		Level A	Level B
Total Reduced Sulphur (TRS)	One Hour	7 ug/m^3	28 ug/m^3
	24 Hour	3 ug/m^3	6 ug/m^3

Table 2.4 lists mean monthly TRS concentrations for each of the five Prince George ambient air staions and their respective annual mean TRS concentrations for 1988.

Values ranged from a high of 19.3 ug/m3 at Jail in October to a low of 0.1 ug/m3 at Lakewood in May and July. The results reveal similar air quality at Plaza, Jail and Foreman Flats. Air quality was better at Van Bien but better yet at Lakewood.

Table 2.4
1988 Summary of Total Reduced Sulphur
for the Prince George Ambient Air Stations in ug/m^3

	Plaza	Jail	Foreman	Lakewood	Van Bien
January	9.5	16.7	13.7	2.4	8.3
February	6.7	13.6	9.4	1.4	4.3
March	6.9	10.9	11.1	1.1	3.2
April	5.3	9.4	6.6	*	3.2
May	5.0	7.7	5.7	0.1	1.5
June	5.2	6.7	7.4	0.3	1.0
July	4.8	6.0	7.8	0.1	1.4
August	3.8	7.3	9.9	0.6	1.0
September	6.2	10.2	9.0	0.3	2.0
October	10.5	19.3	13.6	1.5	4.5
November	10.5	14.4	9.4	2.4	5.6
December	13.2	16.8	9.2	2.2	8.0
Annual Mean	7.3	11.6	9.4	1.1	3.7

* < 67 % Valid Data. Details in Appendix D

Sulphur Dioxide

The sulphur dioxide (SO2) data from the Jail site is summarized in Table 2.5.

Ambient SO2 levels were well within the Provincial objectives except for eight hourly exceedences where hourly average SO2 levels exceeded the level A one hour objective of 450 ug/m3. There was one Level A 24-hour average objective exceedence measured during 1988.

Table 2.5
1988 Summary of Sulphur Dioxide (SO2) Data for the Jail

	Daily Average Values Exceeding		Maximum Daily Average	Hourly Values Exceeding		Hourly Values		
	160ug	260ug	ug/m^3	450 ug/m^3	900 ug/m^3	max	min	mean
January	1	0	173.8	0	0	174.	0	23.7
February	0	0	97.2	1	0	97.	0	21.5
March	0	0	36.5	1	0	37.	0	6.9
April	0	0	22.6	0	0	23.	0	2.3
May	0	0	39.3	0	0	39.	0	10.0
June	0	0	59.6	0	0	60.	0	15.9
July	0	0	87.5	2	0	88.	0	12.5
August	0	0	76.8	0	0	77.	0	14.2
September	0	0	120.1	0	0	120.	0	17.4
October	0	0	89.9	3	0	90.	0	20.9
November	0	0	82.4	1	0	82.	0	10.4
December	0	0	48.2	0	0	48.	0	10.5
Total	1	0		8	0	Annual Average		13.8

Quality of TRS and SO2 Data

The quality of the data collected by the continuous TRS and SO2 monitors was fomerly audited by the Ministry Environment Environmental Laboratory. The number of audits in 1988 were limited to 3 occasions from January to June. The Environmental Lab was privatized in August. Unfortunately only one audit was performed during the remainder of the year but was considered unusable due to calibration equipment problems.

The continuous monitor audit results are listed in Table 2.6. Calibration drifts are listed in percentages. In 1988 all continuous monitors performed within the allowable instrument deviation of + or - 15 %. Audits marked with asterisk* are detailed in Appendix D.

Table 2.6
1988 Continuous Monitor Audit Results (%)

Month	Plaza 400 TRS Philips	Foreman Flats TRS Philips	Lakewood School TRS Philips	Van Bien School TRS Philips	Jail	
					TRS Philips	SO2 Teco
Jan.	<5%	-18%	*	<5%	-8%	<5%
Apr.	<5%	-7%	**	<5%	-10%	-10%
Jun.	+7%	+9%	+12%	<5%	<5%	+6%

* Instrument set up
** Instrument down

The percent valid data for each of the gaseous analyzers are summarized in Table 2.7. Percent valid data was generally very high in 1988 for all of the continuous monitors on a monthly and annual basis. Daily and weekly instrument calibrations limit each instrument's percent valid data to a possible maximum of 96%. Months with percent valid less than 67 % are excluded from further statistical data analysis and are explained in Appendix D.

Table 2.7
Percent Valid Data (%) of the Gaseous Analyzers

	Plaza	Foreman	Lakewood	Van Bien	Jail	
Parameter	TRS	TRS	TRS	TRS	TRS	SO2
January	95.2	94.9	71.9	94.5	94.9	95.0
February	95.0	95.3	94.7	95.1	94.7	95.0
March	94.9	94.9	87.2	90.1	94.1	94.0
April	95.0	94.6	(25.0)*	94.6	93.5	93.9
May	94.6	95.3	95.0	95.2	95.2	95.3
June	94.9	94.9	95.3	95.0	84.7	95.0
July	95.3	95.3	83.3	94.8	94.9	94.9
August	91.7	95.2	95.0	95.0	95.8	96.4
September	94.7	75.0	90.1	95.1	95.6	97.6
October	96.0	93.4	94.8	95.3	95.4	97.4
November	91.1	95.1	95.1	83.8	95.1	97.2
December	95.2	87.2	90.7	92.7	95.3	97.4
Annual Average	94.5	92.6	84.8	93.4	94.1	95.8

* Note: Data Percentages in brackets, (< 67 %), are explained in detail in Appendix D.

Sulphation Rate

Sulphation index data are summarized in Table 2.8 for 1988. The only station where exceedances of the commonly used guideline of 0.5 mg SO3/(dm2.d) were recorded was at the site just north of the Husky Oil Refinery. At this location the guideline was exceeded 45 % of the time. The other stations reported mean and maximum sulphation indices well below the guideline.

Table 2.8
Summary of Sulphation Index for 1988

Station	Sulphation Index mg $SO_3/(dm^2.d)$ Avg.	Min.	Max.	No. of Values	No. of Values > 0.5 mg $SO_3(dm^2d)$
Foreman	.24	.12	.30	12	0
Plaza	.16	.06	.25	12	0
Van Bien	.12	.05	.19	12	0
Lakewood	.04	.03	.07	9	0
North of Husky	.45	.18	.61	11	5
Old Fraser Bridge	.19	.13	.26	12	0
Northwood Lagoons	.18	.01	.27	11	0

Ambient Air Quality Guideline: 0.5 mg SO3/(dm^2.d)

2.2 Particulate

Dustfall

The dustfall data collected at the four monitoring sites are summarized in Table 2.9. Analysis of the data indicates:

1. The maximum measured monthly value was 2.26 mg/(dm2.d) at Plaza. The Plaza site also recorded the highest annual average for the seventh straight year.

2. The lowest annual average dustfall concentration of 0.73 mg/(dm2.d) was observed at Lakewood, with Van Bien close behind.

3. The Level A residential objective of 1.75 mg/(dm2.d) was exceeded twice at Plaza.

Table 2.9
1988 Summary of Dustfall

Station	Total Dustfall Avg mg(dm^2.d)	Min	Max	No. of Values	No. of Values > 1.75	No. of Values > 2.90
Foreman	1.05	.69	1.6	12	0	0
Plaza	1.44	.46	2.26	12	2	0
Lakewood	0.73	.33	1.45	12	0	0
Van Bien	0.76	.31	1.09	11	0	0

B.C. Ambient Air Quality Objectives:
Residential - 1 month 1.75 mg/(dm^2.d)
Other - 1 month 2.90 mg/(dm^2.d)

Total Suspended Particulates (TSP)

Table 2.10 summarizes the total suspended particulate data for 1988.

Analysis of the data indicates:

1. The maximum 24 hour TSP value of 256 ug/m3 was observed at the Plaza site.

2. Continuing the trend since 1982, Plaza recorded the highest geometric mean of 51.9 ug/m3.

3. At Plaza, 10 % of the values exceeded the Federal 24-hour objective of 120 ug/m3 with 5% of the values exceeding the Provincial 24-hour Level A objective of 150 ug/m3. The Provincial 24-hour Level B objective of 200 ug/m3 was exceeded on one occasion (2% of the time).

4. At Lakewood, 8% of the values exceeded the Federal 24-hour objective of 120 ug/m3. The Provincial objectives were exceeded on two occasions or 3% of the time.

5. At Van Bien, 7% of the values exceeded the Federal 24-hour objective of 120 ug/m3. The Provincial 24-hour Level A objective of 150 ug/m3 was exceeded 3% of the time or on two occasions. The Provincial 24-hour Level B objective of 200 ug/m3 was exceeded on one occasion (3% of the time).

6. The one year geometric mean Provincial Level A and Federal objective of 60 ug/m3 was not exceeded at any site during 1988.

Table 2.10
1988 Summary of Total Suspended Particulate Data
Results in ug/m^3

Monitoring Station	No of Values	Min	Max	Geometric Mean	No. of Daily Values > 120 ug/m^3	> 150 ug/m^3	> 200 ug/m^3
Foreman	59	9	132	33.9	1	0	0
Plaza	60	19	256	51.9	6	3	1
Lakewood	60	<2	172	31.8	5	2	0
Van Bien	59	14	203	49.5	4	2	1

B.C. Ambient Air Quality Objectives:

	Level A	Level B	Federal
24 Hour	150 ug/m^3	200 ug/m^3	120 ug/m^3
1 Year Geo. Mean	60 ug/m^3	70 ug/m^3	60 ug/m^3

3. METEOROLOGICAL INFORMATION FOR 1988

3.1 Analysis of 1988 Data

During 1988, five Meteorological Information Stations (MIS) were operated by the Ministry of Environment. These stations are listed in Table 3.1 showing their exact location, elevation, and percent valid data for the past two years.

As indicated the stations at P.G. Pulp and Northwood Pulp were installed in mid June 1987 but for this report a years'worth of data is available for analysis.

Table 3.1
1988 MIS Stations with Percent Valid Data

Station Name	Location	Elevation Meters	Percent Valid Data 1987	1988
Foreman Flats	53 56 20 Lat 122 40 45 Long	578	96.4	89.2
Plaza 400	53 54 50 Lat 122 44 30 Long	595	99.7	96.3
Van Bien	53 53 25 Lat 122 45 50	594	97.7	95.7
Northwood	53 58 03 Lat 122 41 27	577	*	92.1
PG Pulp	53 55 28 Lat 122 41 10	600	*	85.1

* Stations Installed June 1987

The percent valid data for each of the MIS stations is listed by month and annual average in Table 3.2. Generally the percent valid data for the stations is very good, with the exception of one major malfunction as noted at P.G. Pulp.

Table 3.2
1988 MIS Station Wind Magnitude and Direction
Percent Valid Data

Month	Foreman	Plaza	Van Bien	PG Pulp	Northwood
January	86.6	93.5	86.4	69.0	64.7
February	77.0	79.0	71.0	81.9	66.7
March	99.5	100.	99.7	99.6	99.9
April	97.2	99.4	100.	98.1	99.0
May	89.2	100.	100.	9.3*	100.
June	89.6	100.	100.	67.5	95.1
July	60.8	88.3	100.	100.	81.9
August	99.2	100.	100.	100.	100.
September	100.	96.4	100.	100.	100.
October	98.7	100.	100.	100.	100.
November	88.8	99.3	97.6	99.2	99.6
December	83.9	99.6	94.2	96.0	98.8
Average	89.2	96.3	95.7	85.1	92.1

* Anemometer failure

3.2 Analysis of Wind in Prince George

Speed

Table 3.3 compares average annual wind speeds in kilometers per hour between 1982 and 1988. Wind speeds recorded at Plaza, Foreman and Van Bien were nearly the same average annual wind speeds as those recorded in 1987. P.G. Pulp recorded the highest annual wind speed (8.9 km/hr) of the five stations.

The airport's 1988 average annual wind speed of 9.6 km/hr is somewhat lower than that recorded during the last few years.

Table 3.3
Average Annual Wind Speed in km/hr 1982 - 1988

Station	1988 km/hr	1987 km/hr	1986 km/hr	1985 km/hr	1984 km/hr	1983 km/hr	1982 km/hr
Foreman	5.6	5.5	5.7	6.1	4.9	4.0	7.5
Plaza	8.2	8.1	8.0	8.2	7.2	6.4	7.2
Van Bien	7.0	7.0	6.0	6.3	6.8	6.9	5.9
PG Pulp	8.9	*					
Northwood	6.9	*					
Airport	9.6	9.8	10.7	10.4	9.5	8.9	8.5

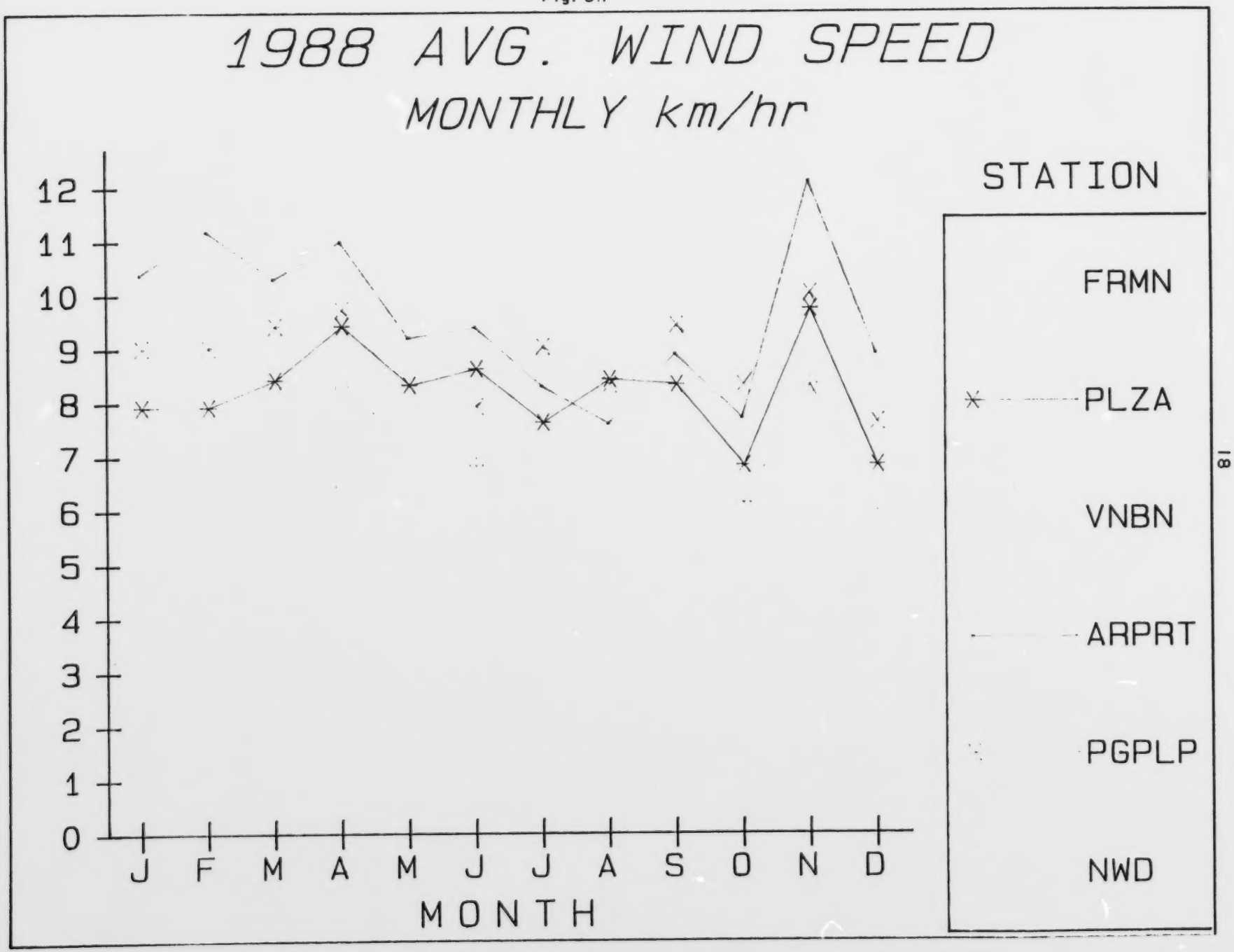
* Stations Installed June 1987

Table 3.4 and Figure 3.1 show a summary of the mean monthly wind speeds in kilometers per hour. As in the past number of years, a notable increase in wind speeds has occurred during the spring with a gradual decrease noted through summer and autumn. All stations have illustrated this trend. In addition, all stations have shown an increase in mean monthly wind speed in November with a marked decline in December. The months of October and December appeared to have the lowest wind speeds at most stations in the MIS network.

Table 3.4
1988 Summary of Mean Monthly Wind Speed in Km/hr

Station	J	F	M	A	M	J	J	A	S	O	N	D	Annual Mean
Foreman	5.4	5.8	5.8	6.5	5.8	5.0	5.8	5.0	5.4	5.4	6.5	4.7	5.6
Plaza	7.9	7.9	8.4	9.4	8.3	8.6	7.6	8.4	8.3	6.8	9.7	6.8	8.2
Van Bien	7.2	7.6	7.2	7.6	6.8	6.8	6.8	6.5	7.2	6.1	8.3	5.8	7.0
PG Pulp	9.0	9.0	9.4	9.7	M*	7.9	9.0	8.3	9.4	8.3	10.0	7.6	8.9
Northwood	6.8	7.2	7.6	8.3	7.2	6.8	6.1	5.8	6.8	6.1	8.3	6.1	6.9
Airport	10.4	11.2	10.3	11.0	9.2	9.4	8.3	7.6	8.9	7.7	12.1	8.9	9.6
Airport 25 yr avg	11.4	11.9	11.9	11.7	10.8	9.9	8.7	8.3	10.3	12.5	12.2	12.1	12.1

Fig. 3.1


1988 AVG. WIND SPEED
MONTHLY km/hr
12
11
10
9
8
7
6
5
4
3
2
1
0
J F M A M J J A S O N D
MONTH
STATION
FRMN
PLZA
VNBN
ARPRT
PGPLP
NWD

A wind vector is measurement of magnitude, using wind speed and direction to describe net movement of an air parcel over a period of time. The measurement of very light winds, wind vectors <1.0 m/sec are listed in Table 3.5 for the years from 1986 - 1988 and summarized in Figures 3.2 to 3.4. Typically poor air quality is usually associated with very light to calm winds. The MIS system does not identify speeds of 0 m/sec. Wind vectors with magnitudes of less than 1.0 m/sec indicate minimal or slow air movement. The percent frequency of wind vectors were generated by taking the number of hours where the wind vectors were <1.0 m/sec and dividing by the number of hours of valid wind data in a month.

Table 3.5
Percent Frequency of Wind Vector < 1.0 m/sec
1986 - 1988

	Plaza			Van Bien			PG Pulp			Northwood		
Month	1986	1987	1988	1986	1987	1988	1986	1987	1988	1986	1987	1988
January	31	41	35	43	46	50	**	**	35	**	**	47
February	45*	38	31	44	49	33			22			35
March	15*	33	34	41	40	38			21			33
April	19	29	24	21	35	35			22			29
May	28*	26	30	36	31	37			22*			36
June	25	26	27	33	33	38			33			38
July	29	24	29	30	37	35			25			41
August	37	31	34	47	36	33			26			43
September	32	40	36	34	42	40			27			43
October	53	42	51	55	48	54			33			49
November	25	27	27	25	41	36			19			25
December	39	28	45	50	33	56			44			47
Annual Average	32	32	34	38	39	40			27			39

* Denotes months with percent vaid data < 67%
**Data unavailable

Fig. 3.2

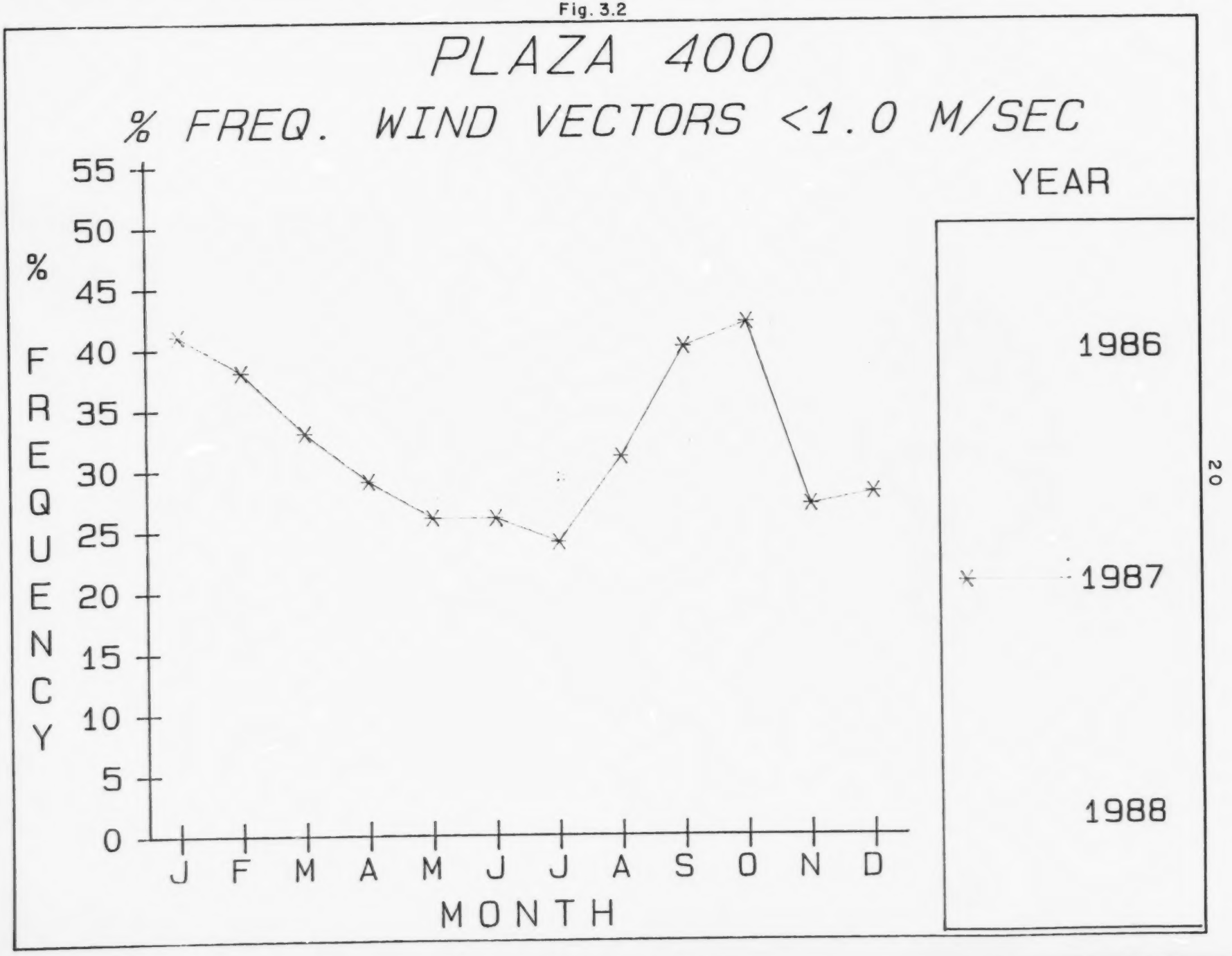

PLAZA 400
% FREQ. WIND VECTORS <1.0 M/SEC
% FREQUENCY
55
50
45
40
35
30
25
20
15
10
5
0
J F M A M J J A S O N D
MONTH
YEAR
1986
1987
1988

Fig. 3.3

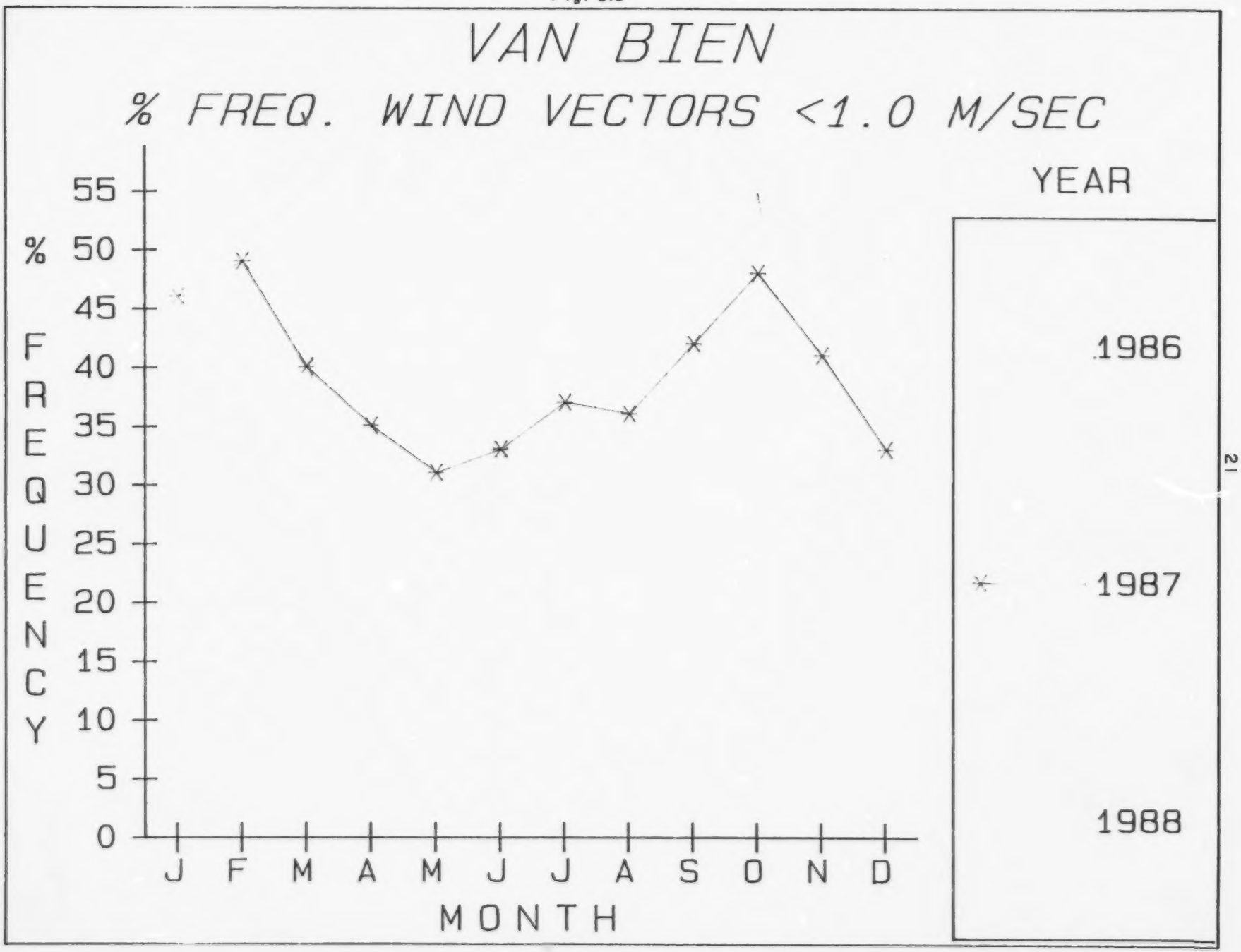
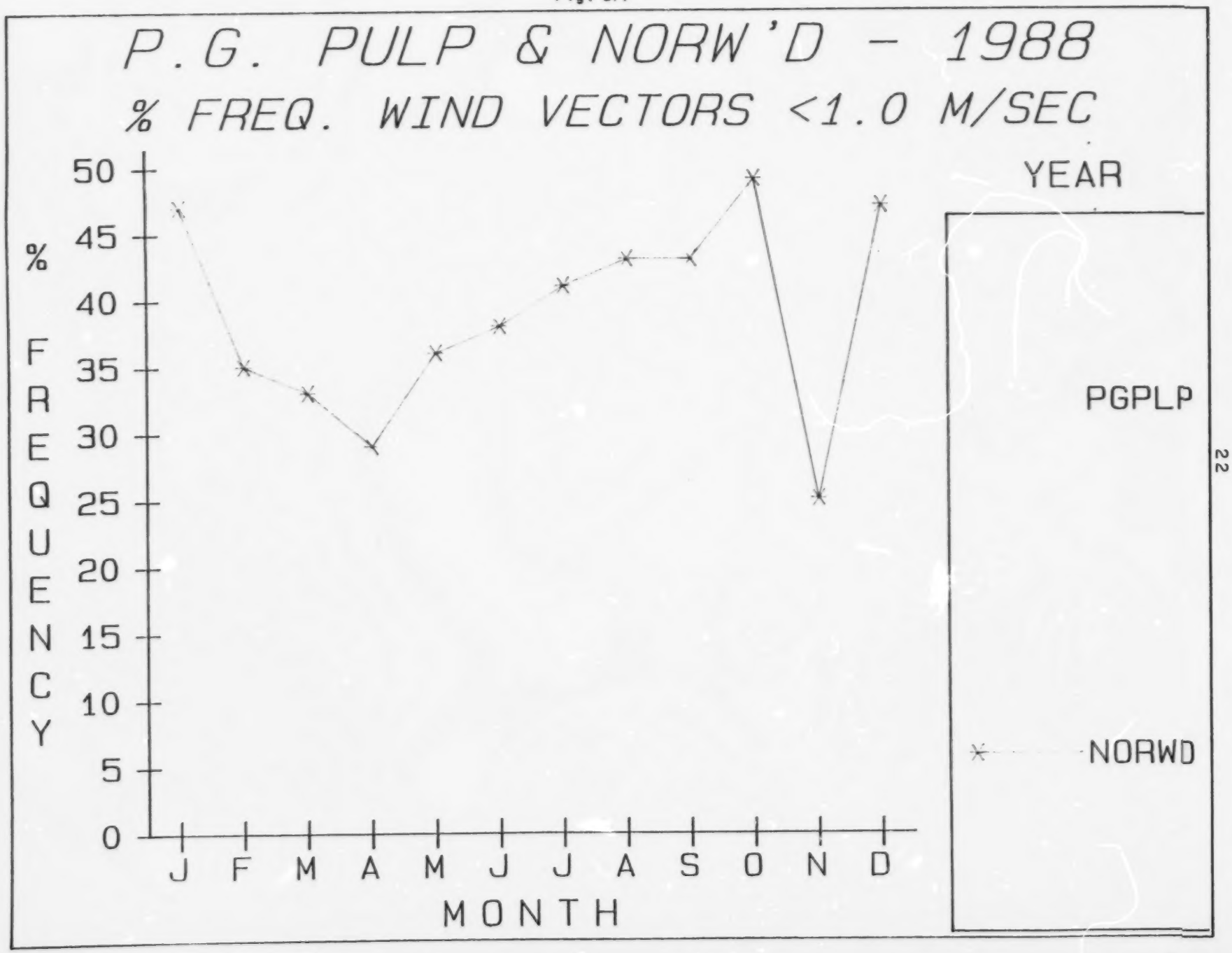

VAN BIEN
% FREQ. WIND VECTORS <1.0 M/SEC
% FREQUENCY
55
50
45
40
35
30
25
20
15
10
5
0
J F M A M J J A S O N D
MONTH
YEAR
1986
1987
1988

Fig. 3.4


P.G. PULP & NORW'D - 1988
% FREQ. WIND VECTORS <1.0 M/SEC
% FREQUENCY
50
45
40
35
30
25
20
15
10
5
0
J F M A M J J A S O N D
MONTH
YEAR
PGPLP
NORWD

The data summary from Table 3.5, collected from Plaza, Van Bien, P.G. Pulp and Northwood shows a number of general trends that are consistent from year to year. January shows a higher frequency to very light winds. From February or March to June the frequency of light winds decrease. A slight increase in frequency of light winds is noted from July to October. November and December show no clear trend from one year to the next as evident from Plaza and Van Bien.

The years 1986, 1987, and 1988 at Plaza and Van Bien are quite consistent in terms of the annual average.

Direction

In order to assess the change in vector direction from year to year, histograms were prepared for each station comparing the percent frequencies of vector wind direction to sixteen compass points.

Figure 3.5 shows the percent frequency of vector wind direction for Van Bien for the period 1986-1988. South-southeast and south are by far the dominant directions. Northwest, north-northwest, north, and north-northeast are secondary in dominance.

Figure 3.6 shows the percent frequency of vector wind direction for Plaza 400 for the period 1986-1988. The dominant wind direction is from the south. South-south west, southwest, and west-southwest are of nearly equal magnitude. Winds from the east, however, were ranked second in terms of percent frequency.

Figure 3.7 shows the percent frequency of vector wind direction for P.G. Pulp and Northwood stations for 1988. At P.G. Pulp the predominant wind direction is south-southwest with south and southwest generally dominant. North and North-northeast are the next predominant direction. At Northwood the predominant wind direction is west-southwest, with south to southwest as the next predominant wind direction. North to east-northeast is the next predominant wind direction.

Fig. 3.5

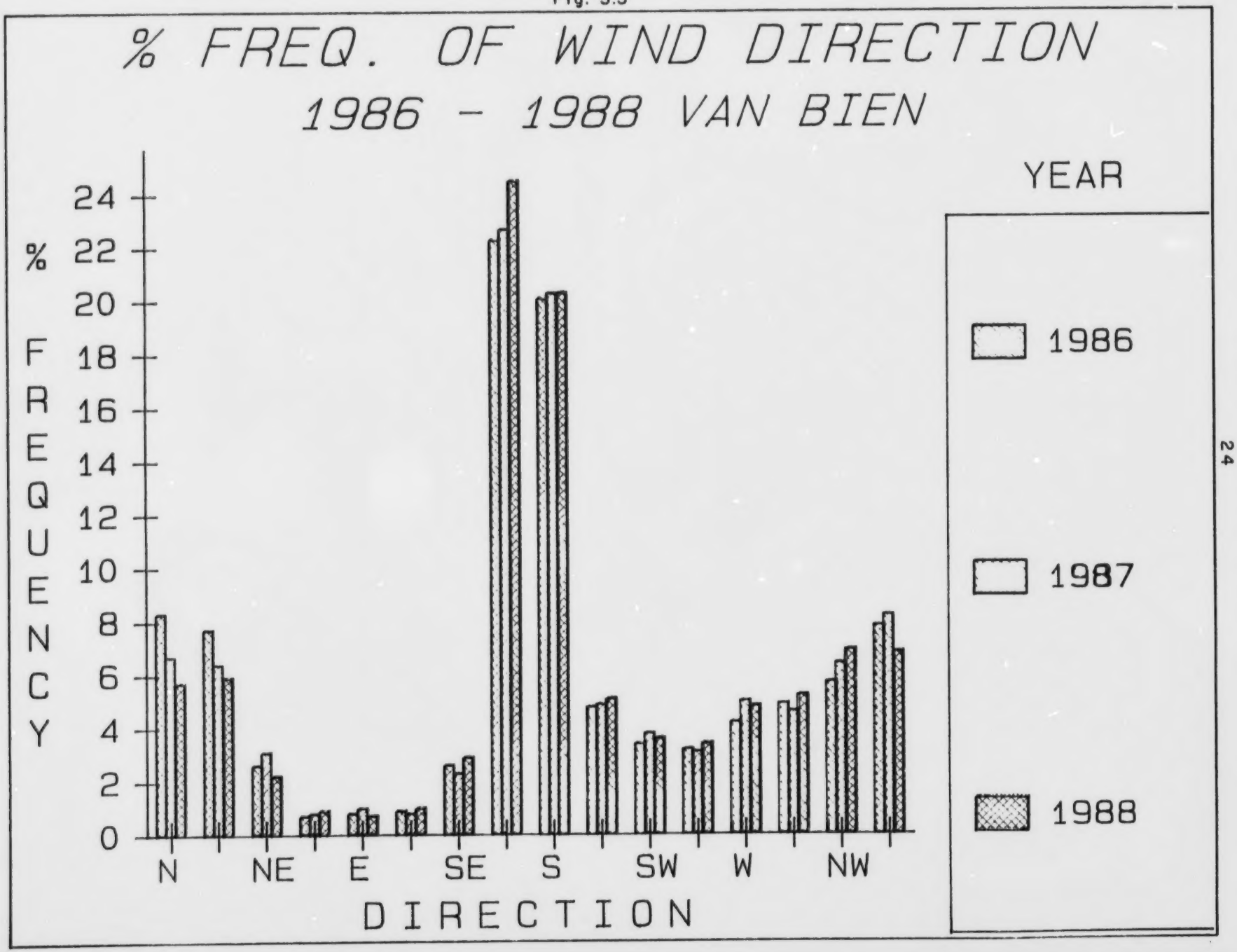

% FREQ. OF WIND DIRECTION
1986 - 1988 VAN BIEN
% FREQUENCY
0
2
4
6
8
10
12
14
16
18
20
22
24
N
NE
E
SE
S
SW
W
NW
DIRECTION
YEAR
1986
1987
1988

Fig. 3.6

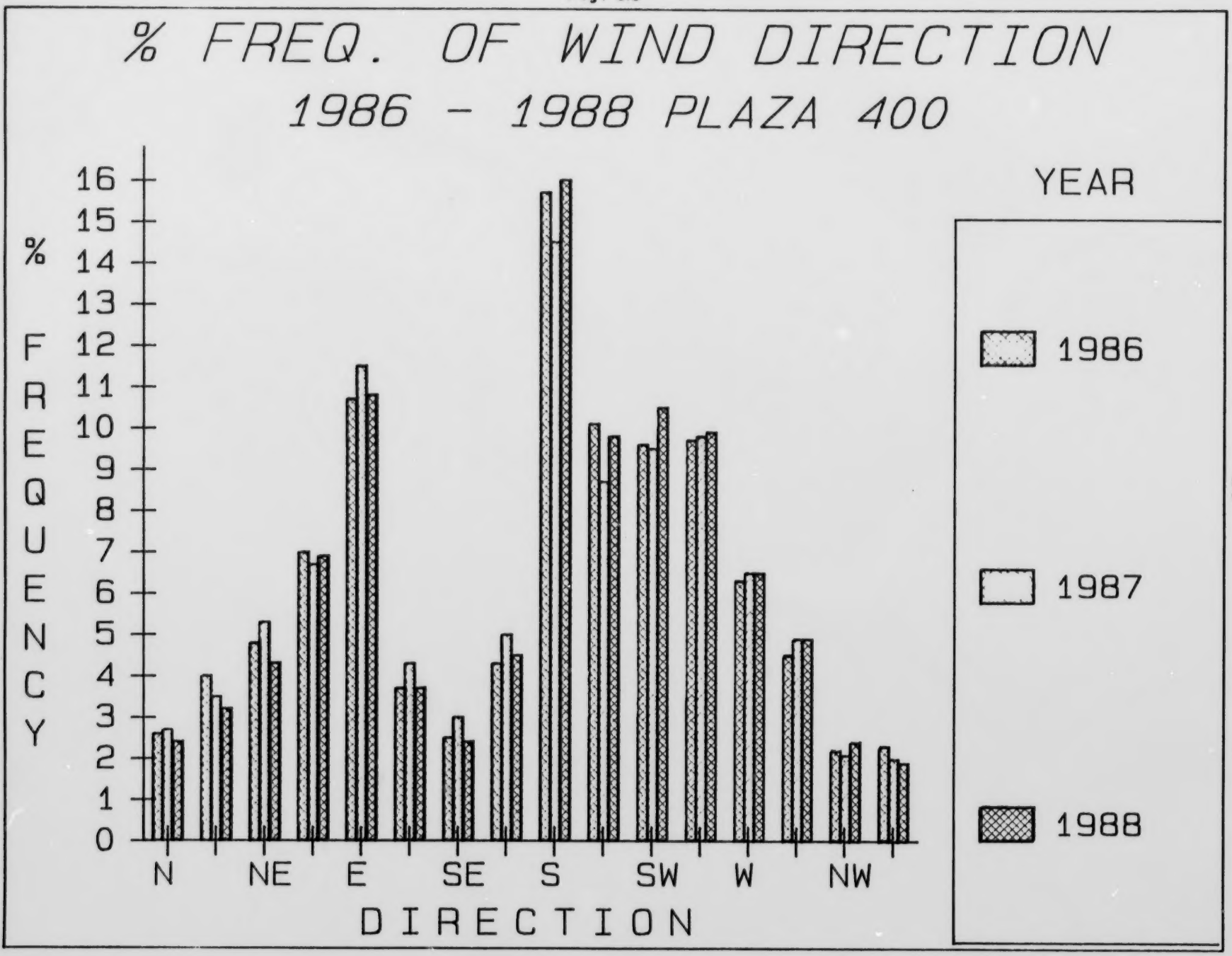

% FREQ. OF WIND DIRECTION
1986 - 1988 PLAZA 400
% FREQUENCY
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
N
NE
E
SE
S
SW
W
NW
DIRECTION
YEAR
1986
1987
1988

Fig. 3.7

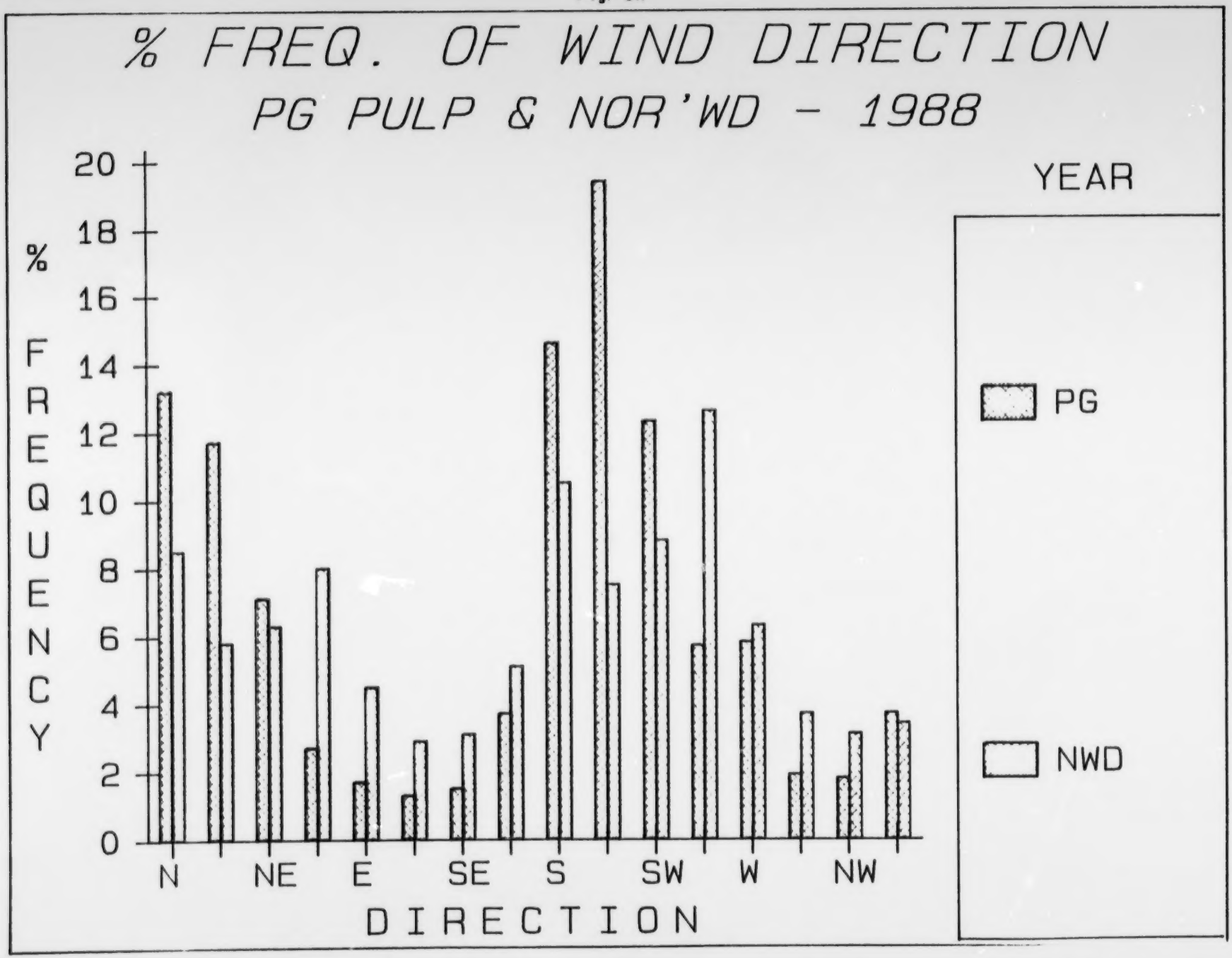

% FREQ. OF WIND DIRECTION
PG PULP & NOR'WD - 1988
% FREQUENCY
20
18
16
14
12
10
8
6
4
2
0
N
NE
E
SE
S
SW
W
NW
DIRECTION
YEAR
PG
NWD

Table 3.6 and Figure 3.8 summarize the wind vector information from the monthly reports for each station. Wind vectors give a good indication of air movement in the general area of the MIS stations. The meteorological information compiled for 1988 in terms of mean wind vector magnitude and percent frequency of wind vector direction is very similar to 1987 data for three of the stations. Only slight differences are apparent at each of the three stations. Stations located at P.G. Pulp and Northwood were installed in mid-1987 and therefore have only one complete year of data.

Table 3.6
Wind Vector Summaries for 1988

Stations		N	NNE	NE	ENE	E	ESE	SE	SSE
Foreman	D	13.2	6.6	3.7	3.2	4.3	6.7	4.7	7.2
	S	3.6	2.2	1.4	1.4	1.4	1.8	3.2	5.8
Plaza	D	2.4	3.2	4.3	6.9	10.8	3.7	2.4	4.5
	S	7.2	6.1	6.1	4.7	5.0	4.0	4.0	9.0
Van Bien	D	5.7	5.9	2.2	0.9	0.7	1.0	2.9	24.5
	S	3.6	4.0	4.0	2.2	2.5	2.5	4.0	9.0
PG Pulp	D	13.2	11.7	7.1	2.7	1.7	1.3	1.5	3.7
	S	6.5	4.7	4.0	3.6	4.0	4.0	6.1	8.3
Northwood	D	8.5	5.8	6.3	8.0	4.5	2.9	3.1	5.1
	S	5.8	4.0	4.0	4.0	3.2	3.2	3.6	4.0

Stations		S	SSW	SW	WSW	W	WNW	NW	NNW
Foreman	D	14.5	7.3	6.0	6.0	3.9	2.3	3.4	7.1
	S	8.6	6.5	6.1	7.9	8.3	5.8	4.7	4.0
Plaza	D	16.0	9.8	10.5	9.9	6.5	4.9	2.4	1.9
	S	12.6	6.1	6.1	7.2	8.6	8.3	6.8	7.2
Van Bien	D	20.3	5.1	3.6	3.4	4.8	5.2	6.9	6.8
	S	8.3	5.4	5.4	5.8	7.2	5.0	4.0	4.3
PG Pulp	D	14.6	19.4	12.3	5.7	5.8	1.9	1.8	3.7
	S	14.4	9.7	9.0	9.0	11.9	6.8	6.1	5.0
Northwood	D	10.5	7.5	8.8	12.6	6.3	3.7	3.1	3.4
	S	5.8	5.8	6.8	9.7	7.9	5.8	7.6	6.8

D = Percent Frequency of Wind Vector Direction (hours) %

S = Mean Wind Vector Magnitude (km/hour)

Figure 3.8

Prince George Wind Roses
Vector - Sixteen Compass Points
1988

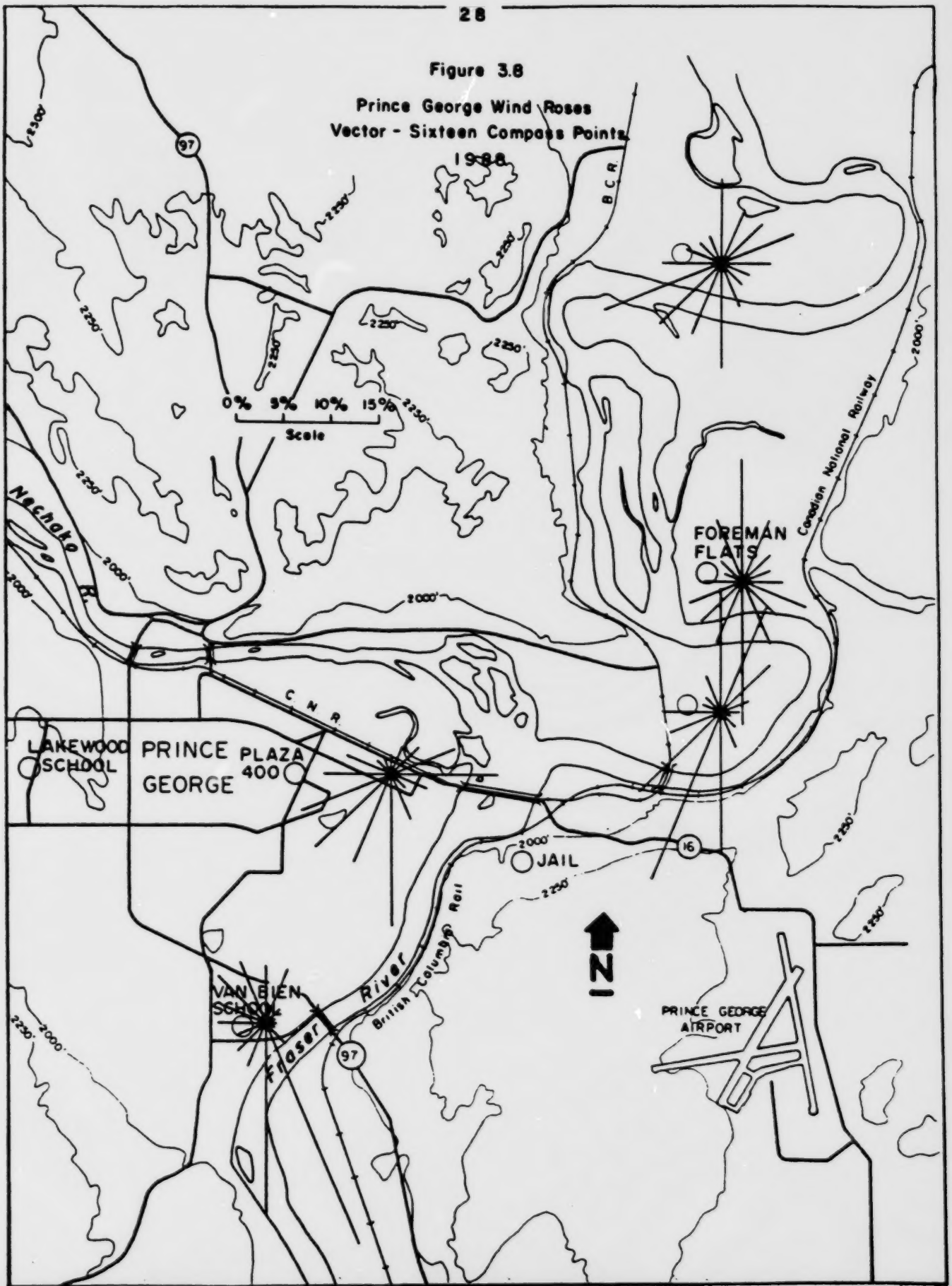


Table 3.7 was prepared in order to assess the variablity in wind vectors as the magnitudes increases and to compare the data for the years 1986 to 1988. The percent frequency of wind vectors less than 1.0 and 2.0 m/sec per quadrant (90 degrees) is listed for the past three years for each station.

All three stations have noted very little change in the percent frequencies of wind vectors as the magnitude increases as was noted from 1986 to 1988.

At Plaza, the highest percent frequency of wind vectors less than 1.0 m/sec are from south to west. The next predominant direction is almost equally divided between north and east and east and south. As the magnitude increases from less than 1.0 m/sec to less than to 2.0 m/sec, the predominant wind direction remains south to west. The next highest percent frequency are for wind vectors from north to east quadrant.

Table 3.7
Percent frequency of Vector Winds Per Quadrant
< 1.0 m/sec and < 2.0 sec m/sec
1986 - 1988

		N to E 1 to 90			E to S 91 to 180			S to W 181 to 270			W to N 271 to 360		
Station	% Frequency	'86	'87	'88	'86	'87	'88	'86	'87	'88	'86	'87	'88
Foreman	<1.0 m/sec	37	37	38	26	28	29	12	12	13	25	23	20
	<2.0 m/sec	12	13	10	28	30	28	33	31	40	27	26	22
Plaza	<1.0 m/sec	24	24	26	25	24	24	41	40	39	13	12	11
	<2.0 m/sec	27	27	28	18	21	19	42	40	42	13	12	11
Van Bien	<1.0 m/sec	20	18	18	26	26	28	23	23	22	31	33	32
	<2.0 m/sec	19	20	16	42	39	42	15	15	20	24	26	22
Pg Pulp	<1.0 m/sec	*	*	50	*	*	13	*	*	19	*	*	18
	<2.0 m/sec	*	*	47	*	*	6	*	*	35	*	*	12
Northwood	<1.0 m/sec	*	*	36	*	*	23	*	*	25	*	*	16
	<2.0 m/sec	*	*	31	*	*	18	*	*	37	*	*	14

*Data unavailable for 1986 - 1987

At Van Bien, the highest percent frequencies less than 1.0 m/sec are from west to north. The next highest percent frequency are from east to south, followed closely by south to west. As the magnitude increases to less than 2.0 m/sec the highest percent frequencies are from east to south. Quadrants south to west and west to north are next in magnitude and almost equal in size.

At Foreman, the highest percent frequency of wind vectors less than 1.0 m/sec are from north to east. The next highest percent frequency are from east to south. At wind vectors less than 2.0 m/sec the highest percent frequencies are from south to west. Wind vectors next in magnitude are from east to south.

At P.G.Pulp, the highest percent frequencies less than 1.0 m/sec are from north to east for 50 % of the time. At less than 2.0 m/sec, the highest percent frequency was also from north to east for 47 % of the time.

At Northwood, the highest percent frequencies less than 1.0 m/sec are from north to east. At less than 2.0 m/sec, the highest percent frequencies are from south to west.

3.3 Meteorological Trends

The installation of two MIS stations in mid-1987 at P.G. Pulp and at Northwood was implemented to investigate the winds of the Fraser Valley north of the Nechako confluence. The year ending 1988 is the first complete year of data collected at both P.G. Pulp and Northwood. Analysis of data from the five stations makes the following apparent:

(1) In terms of annual wind speed, there were no notable changes at Plaza, Van Bien and Foreman, three of the stations that have more than one years' worth of data. Although the annual wind speed declined somewhat during the last two years at the airport, all MIS stations in the Prince George bowl report considerably less wind than at the airport.

(2) In terms of monthly wind speeds all five stations including the airport reported their highest mean wind speed during the month of November. The month of April was next highest in terms of wind speed. In contrast, December and October were months of lowest mean monthly wind speed generally at all stations.

(3) In terms of wind vectors less than 1.0 m/sec (calms), both Plaza and Van Bien, have almost identical percent frequencies between 1986 and 1988.

(4) When the wind at the MIS stations is sorted into sixteen point percent frequency classes, only slight differences are apparent at the Plaza and Van Bien from 1986 to 1988. Differences between stations are typically due to topographical differences.

(5) Analysis of the percent frequency of wind vectors less than 1.0 and 2.0 m/sec per quadrant highlites some of the similarities in air movement between 1986 and 1988. Differences between some stations, those north and south of the Nechako river, are quite substantial. The station at PG Pulp for example shows that for the quadrant North to East for wind speeds <1.0 and <2.0 m/sec is 50% and 47% of the time respectively. The station at Northwood also shows a high percent frequency for winds from this quadrant, 36% for <1.0 m/sec and 31% for <2.0 m/sec.

Generally, the analysis of the 1988 wind data indicates little difference between 1986, 1987 and 1988. Differences between stations, particularly those north of the Nechako confluence, are substantial but are determined primarily by topographical differences.

In 1988, meteorological factors such as synoptic scale phenomena, (frontal passage, movements of high and low pressure regimes,) continue to affect wind flow.

(1) The pattern of seasonal variabilty in meteorological conditions and subsequent air quality are evident. The spring and summer typically have higher wind speeds and better air quality.

(2) Average annual wind speed, wind vector summaries and frequencies of wind vectors indicate very slight differences from year to year, including 1988.

(3) Frequency distributions at Plaza in 1988 show a slight decrease in the percentage of winds from the north and east and a higher percentage of winds from the south, which may explain slightly better air quality noted in 1988 than in 1987.

4. EMISSION SOURCE STATUS

4.1 1988 Emission Source Changes Which Have Influenced the Rate of TRS Emissions

During 1988, the three pulp mills and the oil refinery indicated that there were no changes in equipment and emission sources which would have significantly changed the rate of TRS emissions. Table 4.1 summarizes quarterly TRS values (kg/min) as provided by the three pulpmills. Industrial TRS discharges are also summarized in Appendix C-3. The term "other sources" refers to certain regulated stack sources at the mill other than the recovery boiler. Appendix C-3 lists the specific sources included as "other sources". It has been established that there are additional and significant TRS emissions from the pulp mill effluent lagoons. Effluent emissions are not quantified in this report.

Prince George Pulp and Paper and Intercontinental Pulp's recovery boiler and "other source" TRS emissions have maintained similar levels to those in 1987. Pulp production, Table C-1.1 in Appendix C-1, for those two mills as virtually the same for both years. Northwood's Pulp recovery boiler TRS emissions were approximately 23% higher than the rate emitted in 1987, but "other source" TRS was almost half of 1987 levels. Grand total TRS release by the three pulpmills was 7% lower in 1988 than in 1987. Mean annual ambient TRS concentrations were lower at Plaza (19%), Foreman (6%), Van Bien (16%). Lakewood (31%) but the same at Jail. Figure 4.1 shows the plotted quarterly TRS emissions for all three pulpmills.

4.2 SO2 Emission Source Changes in 1988

Recovery boiler sulphur dioxide emission rates from Intercontinental pulpmill in 1988 were virtually unchanged from last year's rates. Emission rates of sulphur dioxide from P.G. Pulp were 20 % higher in 1988 than the year previously, while Northwood's SO2 emission rates were 54% less than in 1988.

At Husky Oil refinery, incineration of foul water stripper H2S vapours commenced May 1, 1988. This eliminated a source of TRS but has created some SO2, 0.04 kg/min determined on an annual basis. The SO2 from the FCC regenerator stack is higher probably due to feeding crude sludge to FCCU for the last half of 1988. Fugitive emissions were re-measured during 1988 and compressor vents were shown to be larger contributor than previously realized.

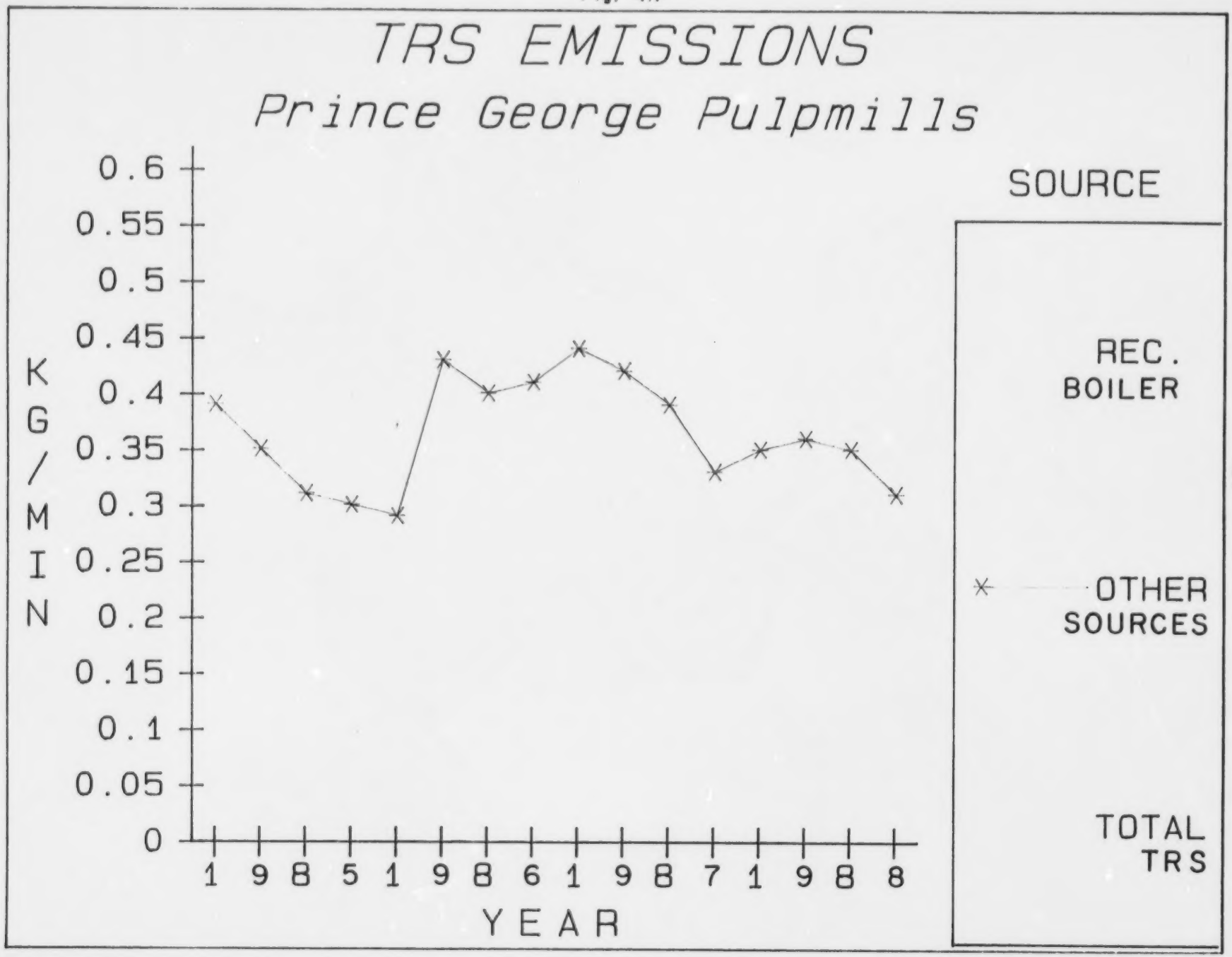
Total SO2 emissions in the airshed increased in 1988. It is difficult to assess this increase in SO2 emissions because only one SO2 ambient monitor is located in Prince George. An increase in the annual average ambient sulphur dioxide concentration was noted at the Jail monitoring station, an 7% increase over 1987. This increase can be attributed to an increase in SO2 emissions and meteorological conditions.

Table 4.1
Summary of Quarterly TRS (as H2S) from the Three Pulpmills in KG/MIN.

		Intercon. Pulp		P.G. Pulp+		Northwood Pulp		Total for Three		
Year	Quarter	Rec. Boiler TRS	Other Source TRS	Rec. Boil TRS	Other Sourc TRS	Rec. Boiler TRS	Other Source TRS	Rec. Boil TRS	Other Sourc TRS	Grand Total TRS
1980	1	2.03	0.41	2.25	0.17	0.18	0.59	4.46	1.17	5.63
	2	1.3	0.15	2.34	0.19	0.27	0.1	3.91	0.44	4.35
	3	0.6	0.15	1.88	0.08	0.1	0.35	2.58	0.58	3.16
	4	0.31	0.21	1.22	0.06	0.04	0.12	1.57	0.39	1.96
1981	1	0.19	0.17#	1.47	0.08	0.12	0.26	1.78	0.51	2.29
	2	0.14	0.15	1.73	0.09	0.11	0.12	1.98	0.36	2.34
	3	0.13	1.11	2.12	0.10	0.10	0.12	2.35	1.33	3.68
	4	0.25	0.24	1.61	0.18	0.04	0.06	1.90	0.48	2.38
1982	1	0.19	0.17	0.72	0.16	0.06	0.13	0.97	0.46	1.43
	2	0.12	0.18	0.82	0.15	0.04	0.14	0.98	0.47	1.45
	3	0.10	0.16	0.25	0.20	0.01	0.07	0.36	0.43	0.79
	4	0.11	0.68	0.21	0.12	0.01	0.04	0.33	0.84	1.17
1983	1	0.11	0.29	0.08	0.10	0.02	0.12	0.21	0.51	0.72
	2	0.12	0.19	0.03	0.10	0.01	0.13	0.16	0.42	0.58
	3	0.23	0.12	0.04	0 10	0.04	0.11	0.31	0.33	0.64
	4	0.19	0.10	0.03	0.11	0.02	0.13	0.24	0.34	0.58
1984	1*	0.17	0.12	0.03	0.12	0.03	0.24	0.23	0.48	0.71
	2	0.13	0.13	0.02	0.11	0.03	0.21	0.18	0.45	0.63
	3	0.11	0.11	0.02	0.15	0.03	0.36	0.16	0.62	0.78
	4	0.06	0.14	0.02	0.11	0.02	0.07	0.10	0.32	0.42
1985	1	0.03	0.15	0.03	0.14	0.05	0.10	0.11	0.39	0.50
	2	0.04	0.14	0.03	0.11	0.05	0.10	0.12	0.35	0.47
	3	0.07	0.11	0.03	0.13	0.03	0.07	0.13	0.31	0.44
	4	0.06	0.12	0.01	0.12	0.03	0.06	0.10	0.30	0.40
1986	1	0.03	0.09	0.02	0.11	0.03	0.09	0.08	0.29	0.37
	2	0.06	0.12	0.02	0.14	0.04	0.17	0.12	0.43	0.55
	3	0.07	0.11	0.03	0.14	0.03	0.15	0.13	0.40	0.53
	4	0.08	0.10	0.03	0.12	0.02	0.19	0.13	0.41	0.54
1987	1	0.06	0.11	0.03	0.13	0.06	0.20	0.15	0.44	0.59
	2	0.07	0.10	0.03	0.11	0.04	0.21	0.14	0.42	0.56
	3	0.06	0.10	0.03	0.12	0.05	0.17	0.14	0.39	0.53
	4	0.04	0.10	0.02	0.11	0.05	0.12	0.11	0.33	0.44
1988	1	0.05	0.11	0.03	0.12	0.07	0.12	0.15	0.35	0.50
	2	0.05	0.14	0.02	0.11	0.05	0.11	0.12	0.36	0.47
	3	0.06	0.11	0.05	0.11	0.08	0.13	0.19	0.35	0.54
	4	0.07	0.10	0.03	0.10	0.06	0.11	0.16	0.31	0.47

* Pulpmills were shut down Feb. 2 -April 10, 1984
\+ Does not include periodic chip bin vent emissions
\# Intercon began montoring chip bin vent emissions in March 1981

Fig. 4.1


TRS EMISSIONS
Prince George Pulpmills
KG/MIN
0.6
0.55
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
1985 1986 1987 1988
YEAR
SOURCE
REC. BOILER
OTHER SOURCES
TOTAL TRS

5.0 INDUSTRY SHUTDOWNS

5.1 Pulpmill Shutdowns

In 1988 all three pulpmills were shutdown at the same time for only one occasion exceeding 24 hours. This occurred beginning on December 24, 1988 and concluding on December 26 for Northwood and December 27, 1988 for Intercon and P.G. Pulp. A detailed list of pulpmill shutdowns longer than 24 hours can be found in Appendix B of this report.

5.2 Husky Oil Refinery Shutdowns

Husky Oil's Refinery shutdowns were limited to:

- A crude, unifiner, and reformer maintenance shutdown from April 2 to April 27.

- The fluid catalytic cracking unit (FCCU) was shutdown from April 8 to May 6.

- The fuel gas treater was shutdown from April 8 to April 26.

6. AIR QUALITY TREND ANALYSIS

The air quality data from the Plaza 400 station (1980-1988), the Jail (1981-1988), and the Lakewood, Van Bien, and Foreman Flats stations (1982-1988) have been examined to reveal air quality trends in Prince George.

6.1 Total Reduced Sulphur

Plaza 400

Table 6.1 summarizes the TRS data from the Plaza 400 station. The period from 1980 to 1982 had no significant change in the frequency of one hour and 24 hour excursions. In 1983, however, a higher frequency of both one-hour and twenty-hour excursions was noted. During the period from 1984 to 1985, the frequency of excursions was significantly below those observed in the previous four years. In 1986, a marked increase in the frequency of excursions has become evident with an increasing trend noted well into 1987. The annual mean TRS concentration of 9.0 ug/m3 and the excursion frequencies of the one hour were the highest observed since 1980. In 1988, the frequency of one and twenty-four hour excursions and annual mean declined below the high of 1987 but not below the 1986 level. The instrument operating hours were higher in 1988 than in any other year.

Foreman Flats

Table 6.3 summarizes the annual TRS data for Foreman Flats from 1982 to 1988. Little variation was evident in percent frequencies of both 1-hour and 24-hour excursions during the period 1982 to 1985. An increase in the annual mean TRS concentrations and frequency of excursions was noted during 1986 and 1987. In 1988, the annual mean and frequencies of excursions declined slightly. The number of hours the instrument operated during 1988 declined slightly but was still higher than in years past.

Table 6.1
Summary of TRS Data at Plaza 400 (ug/m^3)

	Annual Mean	No. of 1 Hour Values		No. of 24 Hour Values		No.of Hours Instrument
Year	ug/m^3	> 7ug/m^3	> 28 ug/m^3	> 3 ug/m^3	> 6 ug/m^3	Operated
1980	5.9	1,085 (16.0 %)	449 (6.6%)	127 (45.0%)	85 (30.1%)	6,772
1981	6.0	1,276 (16.9%)	566 (7.5%)	136 (43.2%)	101 (32.1%)	7,558
1982	5.3	1,241 (15.1%)	445 (5.4%)	156 (45.5%)	111 (32.4%)	8,235
1983	8.6	1,670 (20.7%)	817 (10.1%)	180 (53.4%)	150 (44.5%)	8,082
1984	4.7	978 (11.9%)	372 (4.5%)	121 (35.2%)	84 (24.4%)	8,246
1985	4.8	875 (12.3%)	406 (5.7%)	106 (35.8%)	78 (26.4%)	7,115
1986	7.9	1,295 (20.1%)	677 (10.5%)	126 (46.8%)	102 (37.9%)	6,456
1987	9.0	1,806 (21.8%)	972 (11.7%)	174 (47.7%)	143 (39.2%)	8,280
1988	7.3	1,633 (19.7%)	792 (9.5%)	159 (43.4%)	121 (33.1%)	8,297

Jail

Table 6.2 summarizes the TRS data at the Jail station. During the period 1981 to 1983 a steady increase in the frequency of one-hour and twenty-four hour excursions was noted. A period of better air quality was noted during 1984 and 1985, with a decline in the frequency of both one-hour and twenty-four excursions. The period from 1986 to 1987 shows an increase in the number of excursions and the annual mean. In 1988, the annual mean remained the same as the 1987 high, while a slight increase in the one-hour excursions was noted. The instrument operating hours in 1988 were higher than the previous year.

The annual mean of 11.6 ug/m3 equals the high of 1987, which was the highest ever recorded in the Prince George airshed and at the station.

Table 6.2
Summary of TRS Data at Jail (ug/m^3)

	Annual Mean	No. of 1 Hour Values		No. of 24 Hour Values		No.of Hours Instrument
Year	ug/m^3	> $7ug/m^3$	> 28 ug/m^3	> 3 ug/m^3	> 6 ug/m^3	Operated
1981	7.2	1,673 (21.7%)	638 (8.3%)	151 (47.0%)	121 (37.7%)	7,701
1982	8.8	1,169 (23.8%)	519 (10.6%)	125 (61.0%)	99 (48.3%)	4,915
1983	11.0	2,051 (27.3%)	1,066 (14.2%)	184 (58.8%)	151 (48.2%)	7,511
1984	6.5	1,341 (17.6%)	593 (7.8%)	136 (42.8%)	109 (34.3%)	7,638
1985	6.4	1,483 (19.1%)	546 (7.0%)	145 (44.8%)	117 (36.1%)	7,773
1986	9.8	2,404 (29.1%)	1,028 (12.4%)	197 (57.1%)	169 (49.0%)	8,268
1987	11.6	2,268 (29.0%)	1,306 (16.7%)	200 (54.8%)	175 (47.9%)	7,817
1988	11.6	2,307 (27.9%)	1,343 (16.2%)	197 (53.8%)	166 (45.4%)	8,267

Table 6.3
Summary of TRS Data at Foreman (ug/m3)

	Annual Mean	No. of 1 Hour Values		No. of 24 Hour Values		No.of Hours Instrument
Year	ug/m^3	> $7ug/m^3$	> 28 ug/m^3	> 3 ug/m^3	> 6 ug/m^3	Operated
1982*	7.3	847 (21.6%)	149 (3.6%)	106 (63.9%)	72 (43.4%)	3,978
1983	7.2	1,803 (22.6%)	426 (5.4%)	244 (73.9%)	163 (49.4%)	7,917
1984	7.2	1,728 (22.5%)	351 (4.6%)	203 (63.6%)	140 (43.9%)	7,664
1985	7.6	1,526 (22.2%)	406 (5.9%)	186 (65.0%)	142 (49.7%)	6,860
1986	9.2	1,968 (26.0%)	529 (7.0%)	235 (74.6%)	173 (54.9%)	7,568
1987	10.0	2,485 (30.2%)	706 (8.6%)	278 (76.2%)	226 (61.9%)	8,242
1988	9.4	2,328 (28.6%)	673 (8.3%)	273 (74.6%)	207 (56.6%)	8,134

* Instrument Operated June - December 1982

Table 6.4
Summary of TRS Data at Van Bien (ug/m^3)

	Annual Mean	No. of 1 Hour Values		No. of 24 Hour Values		No.of Hours Instrument
Year	ug/m^3	> $7ug/m^3$	> 28 ug/m^3	> 3 ug/m^3	> 6 ug/m^3	Operated
1982*	3.0	370 (8.8%)	128 (3.0%)	47 (26.7%)	29 (16.5%)	4,224
1983	5.7	1,148 (14.8%)	432 (5.6%)	119 (36.8%)	91 (28.2%)	7,761
1984	2.3	510 (6.9%)	140 (1.9%)	64 (20.7)	41 (13.3%)	7,423
1985	3.4	699 (9.3%)	277 (3.7%)	86 (27.4%)	50 (16.0%)	7,509
1986	4.5	1,198 (14.5%)	468 (5.7%)	127 (36.9%)	86 (25.0%)	8,266
1987	4.4	1,129 (13.8%)	445 (5.5%)	111 (34.8%)	75 (20.5%)	8,159
1988	3.7	1,137 (13.9%)	353 (4.3%)	107 (29.2%)	77 (21.0%)	8,207

* Instrument Operated June - December 1982

Table 6.5
Summary of TRS Data at Lakewood (ug/m^3)

	Annual Mean	No. of 1 Hour Values		No. of 24 Hour Values		No.of Hours Instrument
Year	ug/m^3	> $7ug/m^3$	> 28 ug/m^3	> 3 ug/m^3	> 6 ug/m^3	Operated
1982*	0.9	176 (3.0%)	22 (0.4%)	22 (9.1%)	13 (5.4%)	5,785
1983	2.6	615 (8.0%)	147 (1.9%)	79 (24.5%)	43 (13.4%)	7,737
1984	0.9	199 (2.4%)	15 (0.2%)	34 (9.9%)	10 (2.9%)	8,269
1985	1.0	216 (2.9%)	28 (0.4%)	29 (9.3%)	12 (3.9%)	7,456
1986	1.7	439 (5.6%)	110 (1.4%)	51 (15.7%)	32 (9.9%)	7,807
1987	1.6	461 (6.0%)	106 (1.4%)	51 (14.0%)	34 (9.3%)	7,680
1988	1.1	270 (3.6%)	38 (0.5%)	38 (10.4%)	23 (6.3%)	7,462

Van Bien and Lakewood

Tables 6.4 and 6.5 summarize TRS trends for Van Bien and Lakewood stations for the period 1982 - 1988. Little variability in TRS trends was noted from 1982 to 1985. The years 1983, 1986, and 1987 showed a similar frequency of excursions. At Van Bien in 1988, the annnual mean declined slightly, but the excursions showed relatively little change. At Lakewood, the annual mean declined with a similar decline noted in the frequency of excursions.

The instrument operating hours declined slightly at Lakewood but increased slightly at Van Bien.

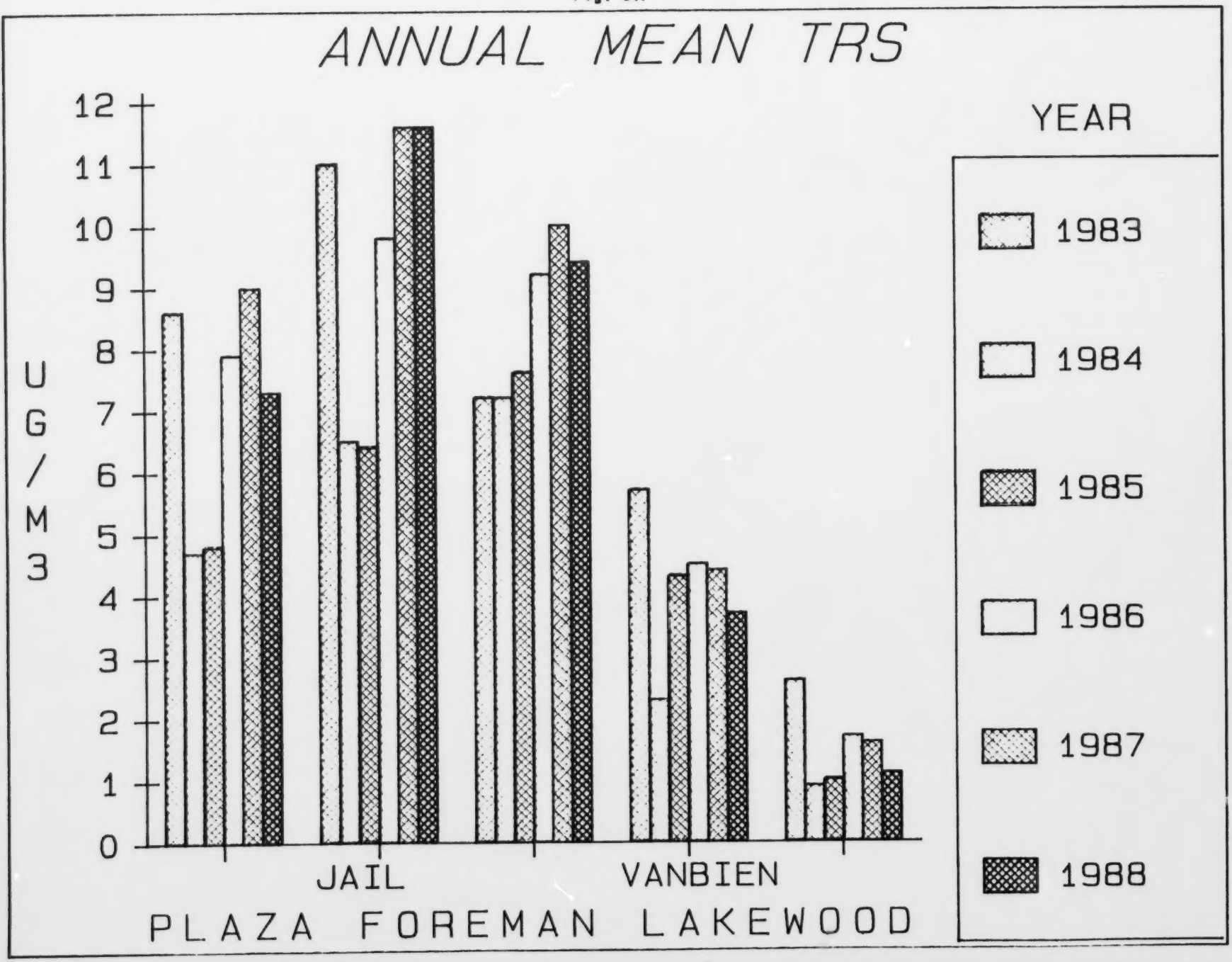
TRS Summary

The annual mean TRS concentrations from 1982 to 1988 are summarized in Figure 6.1.

All stations, with the exception of the Jail, showed a slight decline in the annual average concentration over the previous year. The Jail maintained the same level as in 1987.

Air quality in 1988 was slightly better than in 1987 but not as good as the years 1984 and 1985.

Fig. 6.1


ANNUAL MEAN TRS
UG/M3
0
1
2
3
4
5
6
7
8
9
10
11
12
YEAR
1983
1984
1985
1986
1987
1988
JAIL
VANBIEN
PLAZA
FOREMAN
LAKEWOOD

6.2 Sulphur Dioxide

Table 6.6 summarizes the SO2 data collected at the Jail station. A decreasing trend was evident for annual SO2 concentrations since 1983. The annual averages prior to 1986 were obtained from a Philips SO2 continuous analyzer which were subject to interference from various TRS compounds, resulting in erroneously high values. In 1986 a new SO2 monitor was installed and the SO2 average for 1986 is based upon Philips data for Jan. - Feb. and the new TECO monitor data for Mar. - Dec. The lower annual averages for 1986 and 1987 are attributable to the improved quality of data provided by the new monitor.

Sulphur dioxide emissions in the Prince George airshed increased in 1988 and an increase in the annual average ambient SO2 was noted. It is noted that with only one station measuring SO2, it is likely that not all the ambient SO2 is being measured in the airshed.

Table 6.6
Summary of SO2 Data at Jail (ug/m^3)

	Annual Mean	No. of 1 Hour Values		No. of 24 Hour Values		No.of Hours Instrument
Year	ug/m^3	>450ug/m^3	>900 ug/m^3	>160 ug/m^3	>260 ug/m^3	Operated
1981	10.7	1	0	0	0	7,016
1982	25.5	1	0	0	0	6,535
1983	31.8	1	0	0	0	8,310
1984	22.9	6	1	3	0	7,551
1985	21.0	0	0	0	0	7,860
1986*	16.9	4	0	0	0	8,278
1987	12.8	2	0	0	0	8,348
1988	13.8	8	0	1	0	8,412

*TECO SO2 Monitor installed February 1986

6.3 Dustfall

Tables 6.7 to 6.10 present a summary of total dustfall data as observed at all stations.

A general decreasing trend was observed between 1980 and 1985 at Plaza, Foreman, Van Bien and Lakewood. Most stations reported their minimum average annual dustfall concentrations in 1985, but have since shown an increase in average annual dustfall concentrations.

In 1988, Plaza has shown an increase in the average annual dustfall concentration but still less than the high values observed in 1980 and 1981. Van Bien and Foreman observed declines in their annual averages whereas Lakewood observed its highest annual average since monitoring started in 1982.

Table 6.7
Summary of Dustfall Data at Plaza 400 ($mg/dm^2.d$)

Year	Average ($mg/dm^2.d$)	No. of Samples	No. of Samples > 1.75	No. of Samples > 2.90
1980	1.64	10	5 (50%)	0
1981	1.73	14	6 (43%)	0
1982	1.34	12	3 (25%)	0
1983	1.21	12	2 (17%)	0
1984	0.97	12	0	0
1985	1.02	12	1 (8%)	0
1986	1.20	11	1 (9%)	0
1987	1.36	12	2 (17%)	0
1988	1.44	12	2 (17%)	0

Table 6.8
Summary of Dustfall Data at Foreman Flats ($mg/dm^2.d$)

Year	Average ($mg/dm^2.d$)	No. of Samples	No. of Samples > 1.75	No. of Samples > 2.90
1982	1.45	9	4 (44%)	0
1983	0.94	12	0	0
1984	0.99	12	1 (3%)	0
1985	0.65	12	0	0
1986	0.78	11	0	0
1987	1.08	12	1 (3%)	0
1988	1.05	12	0	0

Table 6.9
Summary of Dustfall Data at Van Bien ($mg/dm^2.d$)

Year	Average ($mg/dm^2.d$)	No. of Samples	No. of Samples > 1.75	> 2.90
1982	0.63	10	0	0
1983	0.65	12	0	0
1984	0.62	12	0	0
1985	0.54	12	0	0
1986	0.61	12	0	0
1987	0.86	11	0	0
1988	0.76	11	0	0

Table 6.10
Summary of Dustfall Data at Lakewood ($mg/dm^2.d$)

Year	Average ($mg/dm^2.d$)	No. of Samples	No. of Samples > 1.75	> 2.90
1982	0.34	11	0	0
1983	0.37	12	0	0
1984	0.39	12	0	0
1985	0.29	12	0	0
1986	0.38	12	0	0
1987	0.57	12	0	0
1988	0.73	12	0	0

6.4 Total Suspended Particulate

Tables 6.11 to 6.14 summarize the total suspended particulate as observed at all stations.

At Plaza, a decreasing trend had been observed from 1980 to 1983 and a stable trend from 1983 to 1985. Both 1986 and 1987 had very similar geometric means. Although the geometric mean declined in 1988, a slight increase in the exceedences of Provincial objectives was noted.

The TSP data collected at Foreman in 1988 continues to show a stable trend in the annual geometric mean and lack of exceedences of Provincial objectives.

Both Van Bien and Lakewood show a trend of decreasing annual means from 1982 - 1984 and an increasing trend from 1985 -1987. In 1988 both stations showed a decline in annual means. Lakewood showed an minor increase in exceedences of Provincial objectives.

In summary, although all geometric means decreased in 1988, Plaza and Lakewood noted an increase in exceedences of the Provincial 24-Hour Level A and Level B objectives.

Table 6.11
Summary of TSP Data at Plaza (ug/m^3)

Year	Annual Geometric Mean ug/m^3	No. of Samples	No. of Samples > 150 ug/m^3	No. of Samples > 200 ug/m^3
1980	76	50	4 (8.0%)	
1981	78	60	5 (8.3%)	
1982	61	61	5 (8.2%)	
1983	51	46	1 (2.2%)	
1984	50	61	3 (4.9%)	
1985	53	61	1 (1.6%)	
1986	62	58	5 (8.6%)	3 (5.2%)
1987	63	59	2 (3.4%)	0
1988	52	60	3 (5.0%)	1 (1.7%)

Table 6.12
Summary of TSP Data at Foreman

Year	Annual Geometric Mean ug/m^3	No. of Samples	No. of Samples > 150 ug/m^3	No. of Samples > 200 ug/m^3
1982	34	13	0	
1983	36	45	1 (2.7%)	
1984	31	59	0	
1985	30	60	0	
1986	31	51	0	
1987	35	56	0	
1988	34	59	0	

Table 6.13
Summary of TSP Data at Van Bien

Year	Annual Geometric Mean ug/m^3	No. of Samples	No. of Samples > 150 ug/m^3	No. of Samples > 200 ug/m^3
1982	54	44	2 (4.5%)	
1983	49	56	2 (3.6%)	
1984	47	60	1 (1.6%)	
1985	50	59	0	
1986	54	58	4 (6.9%)	2 (3.4%)
1987	61	58	3 (5.2%)	1 (1.7%)
1988	50	59	2 (3.4%)	1 (1.7%)

Table 6.14
Summary of TSP Data at Lakewood

Year	Annual Geometric Mean ug/m^3	No. of Samples	No. of Samples > 150 ug/m^3	No. of Samples > 200 ug/m^3
1982	40	50	0	
1983	37	56	2 (3.6%)	
1984	34	58	0	
1985	37	58	2 (3.5%)	
1986	40	59	5 (8.5%)	1 (1.7%)
1987	44	60	0	
1988	32	60	2 (3.3%)	

7. CONCLUSIONS

7.1 Emission Source Status

The three pulpmills have indicated that in 1988 there were no modifications performed on their emission control systems that would have affected the rate of TRS emissions. TRS emission rate data submitted by the companies revealed a slight increase of Northwood's recovery boiler TRS emission rate compared to the 1982-1987 data base.

Husky Oil Refinery indicated their were no changes to their TRS emission sources in 1988. TRS emissions from the refinery are considerably less than from each of the pulpmills.

Sulphur dioxide emission rates from Intercon and P.G. Pulp were similar to previous years. Northwood's SO2 emission rates were approximately half of 1987 and were low compared to most years. Husky's SO2 emission rates from the refinery flare and the F.C.C.U. were the same as 1987.

7.2 Air Quality

i) The total reduced sulphur (TRS, measured as H2S) levels in the Prince George area in 1988 exceeded the Provincial Level B 1-Hour objective ranging from 0.5 % of the time at Lakewood to 16.2 % of the time at the Jail station. The air quality at the Jail, Plaza, and Foreman Flats stations in 1988 was similar to previous years of poor air quality.

Air quality at Van Bien and Lakewoood was average compared to years past. Exceedence frequencies by season revealed the worst air quality occurs in fall and winter .

ii) The average annual SO2 concentration of 13.8 ug/m3 at the Jail station in 1988 was the third lowest since 1981 and as well below the Provincial Level A Annual objective of 25 ug/m3. The Provincial Level A 1-Hour objective was exceeded for 8 hours during 1988. There was one Level A 24-Hour average objective exceedence measured during 1988.

iii) The 1988 dustfall results indicate two out of four stations detected higher average annual dustfall results than in the last six years. Van Bien and Foreman recorded slightly lower annual averages. There were two Level A residential objective exceedences noted at Plaza. The Lakewood station, in 1988, recorded the highest annual average dustfall concentration since 1982.

iv) Although the annual means of total suspended particulate at all four stations decreased in 1988, the levels were similar to other years. All stations met the stringent Level A annual mean objective of 60 ug/m3. At Plaza and Van Bien, the Provincial Level B 24-Hour objective of 200 ug/m3 was exceeded on one occasion.

7.3 Industry Shutdowns

i) In 1988 all three pulpmills were shutdown at the same time for 48 hour period surrounding December 25. No conclusions can be drawn from an examination of such a short duration shutdown. During this shutdown, the Provincial Level A 24-Hour objective was exceeded at the Plaza 400 and Jail ambient air stations.

ii) During 1988 there was a total shutdown of the Husky refinery from April 8 to April 26.

7.4 Meteorological Conclusions

The wind analysis for 1988 included five stations; Plaza, Van Bien, Foreman, P.G. Pulp and Northwood. The last two stations are included in this analysis for the first time. Analysis of the 1988 meteorological data, particularly for the three stations which have operated since 1985, has shown many similarities to past years.

The data has shown:

1) The quality and percent valid data from each of the five stations was good, on average 91.7%.

2) In terms of wind speed, there was no notable change at three of the stations that have more than one year's worth of data.

3) In 1988, the highest mean monthly wind speeds were measured during the month of November. In contrast, the months with the lowest mean wind speeds were December and October. Twenty-five years of airport data reveal that maximum mean monthly wind speeds are usually detected for the months of February, March, October and November.

4) In terms of wind vectors less than 1.0 m/sec (calms), at two of the stations that have more than one year of data, the percent frequencies were almost identical between 1986 and 1988.

8. FOLLOW-UP AND RECOMMENDATIONS

8.1 Follow-up to 1987 Report

i) The Prince George Ambient Air Technical Committee recommended that the TRS monitoring network, as it existed in 1987, will continue unchanged at least through the 1988/89 fiscal year.

ii) The replacement of the Philips continuous TRS monitors with more technologically advanced instrumentation has been tentatively planned for the spring of 1989. It is anticipated that the Philips and the new instrumentation will be run side by side for a sufficient period of time to determine comparability. After that time a decision will be made when to shut down the Philips analyzers.

iii) A program of further investigation into TRS emissions from the pulpmill effluent and ambient speciation at the Plaza has been started. This program was initiated to determine if the various TRS gaseous compounds detected at selected pulpmill lagoons are impacting on the TRS monitors located at the ambient air stations. However, problems with equipment, a portable gas chromatograph have interrupted the progress of the program. The "finger-printing" of the various TRS compounds may prove beneficial in determining their source.

iv) An analysis of the wind data from the MIS stations located at P.G. Pulp and Northwood has been delayed because of an error in the alignment of the reference direction at the Northwood site. The reference point was found to be out 61 degrees from true north and it was decided re-start the analysis rather than try to correct data from an unknown starting point. It is hoped that the report will be forth coming in the near future and will provide insight into the complex valley winds.

8.2 Recommendations

The Prince George ambient air monitoring program should be reviewed before the end of 1989 to evaluate the following:

i) Establish exactly how well the Monitor Lab TRS analyzer are performing and how comparable the data is to that from the Philips TRS analyzers.

ii) An evaluation of the meteorological data collected from the three wind stations north of Canfor and Husky is required to improve our understanding of wind patterns in this area of the valley.

iii) Review the monitoring network to ensure that instruments are well located for monitoring improvements in air quality as upgrading programs are brought on line and to address any other ambient air issues that are referred to the Committee.

APPENDICES

Appendices A and F deal with air quality objectives and photographs have not been repeated here as there have been no significant changes to them since their inclusion in the 1982 report.

Appendices B, C, D, and E deal with industry shutdowns, emission sources, program description anomalies, and maps have been updated to reflect amendments to the data and to show any changes noted for 1988.

Appendix B- Industry Shutdowns

Tables B-1.0 and tables B-2.0 show pulpmill shutdowns since 1982 and refinery shutdowns since 1983, respectively. For the purpose of this report a shutdown is defined as a total mill shutdown (or zero TRS and SO2 stack emissions) for periods of 24 hours or longer.

TABLE B-1.0
Pulpmill Shutdown Periods

	Northwood	Intercontinental	P.G. Pulp
1982	Jan. 1 Apr. 12-18 Jul. 1 Sept. 6 Nov. 9 Dec. 24-31	Jan. 1-2 Jan. 20-21 Mar. 23-25 May 15-Jun.3 Jul. 1-2 Sept. 5-7 Oct. 23-Nov. 18 Dec. 23-31	Jan. 1 Apr. 12-16 Jul. 1 Sept. 6 Oct. 25-Nov. 23 Dec. 25-31
1983	Jan. 1 Apr. 1-17 Jul. 1 Nov. 11 Dec. 25-31	Jan. 1-6 Feb. 16 Apr.4-5 Jun. 22-23 Jul. 1-2 Aug. 5-6 Sept. 6 Sept. 23 Oct. 21-30 Nov. 17 Dec. 24-27	Jan. 1-6 Apr. 4 Apr.25-May 6 Jul. 1 Sept. 23 Oct. 21-29 Nov. 14-15 Dec. 25-26
1984	Jan. 1-2 Feb. 2- Apr. 12 Apr. 23 Jul. 2 Sept. 3 Oct. 1-2 Dec. 25-26	Jan. 1-2 Feb. 1-Apr. 10 Apr. 22-24 May 1-2 Jul. 1-3 Sept. 2-4 Oct. 20-Nov. 7 Dec. 24-27 Dec. 31	Dec. 31-Jan.1 Feb.2-Apr. 10 Apr. 23 Jul. 2-8 Sept. 3 Nov. 11-15 Dec. 24-26

TABLE B-1.0
Pulpmill Shutdown Periods (continued)

	Northwood	Intercontinental	P.G. Pulp
1985	Jan. 1 Apr. 8-21 Apr. 21 Jun. 30-Jul. 23 Sept. 2 Oct. 2-18 Dec. 23-31	Jan. 1 Apr. 8 Apr. 15-May 8 Jul. 1 Aug. 25-Sept. 8 Dec. 17-31	Jan. 1 Apr. 8 Apr. 15-May 6 Jul. 1 Aug. 24-Sept. 8 Dec. 18-31
1986	Jan. 1-2 Aug. 21 Oct. 14-16 Dec. 24-26	Jan. 1-2 Feb. 25-26 Mar.30- Apr. 1 Apr. 20-May 8 Aug. 30-Sept. 6 Nov. 27-28	Jan. 1-2 Mar. 31-Apr.1 Apr. 20-26 Sept. 1-2 Sept. 28-Oct. 3 Dec. 24-27
1987	Apr. 20-21 Oct. 16-24 Dec. 24-26	Apr. 20-26 Jun. 1-2 Oct. 17-25 Dec. 23-27	May 9-15 May 31-Jun. 2 Sept. 6-11 Dec. 23-27
1988	 Apr. 4-6 Oct. 21-24 Dec. 24-26	Jan. 19-21 Sept. 4-11 Dec. 3-5 Dec. 24-27	 Apr. 17-22 Sept. 5-6 Oct. 23-29 Dec. 24-27

Table B-2.0 list the dates when the various major emission sources at the Husky Oil Refinery were shutdown for 24 hours and more from 1981 to 1988.

Husky Refinery Shutdown Periods

	FCCU	Reformer	Unifiner	Crude	Fuel Gas Treater	Sulphur Recovery	Vacuum
1981	Jan. 31- Feb. 12 Apr. 6-14 May 4- Jun. 4 Aug. 3 Aug.10-15 Aug.20-25 Sept.4-10 Nov. 1-3	Feb.18-23 Apr. 8-12 May 2-23 Jun. 4-8 Jun.15-17 Jun.19-26 Sept.9-18	Feb.18-23 Apr. 8-12 May 2-23 Jun. 4-8 Jun.15-18 Jun.19-26 Sept.2-3 Sept.9-18	Feb.18-23 Apr. 8-11 May 2-23 Jun. 4-26 Sept.2-3 Sept.9-18			
1982	 May 12- Jun. 11		Mar.8-9 May 1-25 May 30- Jun. 4	Mar.8-9 May 1-24	May 12-24	Operated 3 hrs. in Aug. only	May 1-24
1983	Mar.19-27 Mar.28-31 Jun.12-15 Jul. 7-19	 Jul. 7-9 Sept. 24- Oct. 2	Mar.21-22 Jun. 6-7 Jul. 7-9 Sept. 24- Oct. 3	Mar.21-22 Jun. 6-7 Jul. 7-9 Sept. 24- Oct. 3	 Jul. 7-14	Did not operate in 1983	
1984	Apr. 22- Jun.7 Jun. 22- Jul. 5 Dec. 17 Dec.27-31	Apr. 20- May 29 Oct. 9-12	Apr. 20- May 29 Aug.17-18 Oct. 9-12	Apr. 20- May 29 Oct. 9-12	Mar.20- Apr. 2-4 Apr.22- May 29	Did not operate	Did not operate
1985	Jan. 1-9 Apr. 24- Jun. 16 Sep.23-28	Apr.17- Jun. 7 Jun.10-14 Jul. 28- Aug. 1	Apr. 17- Jun. 7 Jun.9-14 Jul. 28- Aug. 1	Apr. 17- Jun. 6 Jun.10-14 Jul. 28- Aug. 1	Apr.24- Jun. 7	Did not operate	Did not operate

Husky Refinery Shutdown Periods (cont'd)

	FCCU	Reformer	Unifiner	Crude	Fuel Gas Treater	Sulphur Recovery	Vacuum
1986	May 24-Jun. 2 Jul. 7-10	Sept.26-Oct. 6	Mar. 8-9 Sept. 26-Oct. 7	Sept.26-Oct. 6	May 29-30 Sept. 29-Oct. 4	Did not operate	Did not operate
1987	Jul. 5-11 Nov.11-14 Dec. 2-4	Apr. 2-7	Apr. 2-7	Apr. 2-7	Sep.29-30		
1988	Apr. 8-30 May 1-6	Apr. 2-27	Apr. 2-27	Apr. 2-27	Apr. 8-26		

Appendix C - Emission Sources

C-1 Description of Major Industrial Complexes

The sources of the gaseous contaminants measured by this monitoring program include three pulpmills and oil refinery located in Prince George. The principle gaseous contaminants are TRS and sulphur dioxide (SO2).TRS is primarily emitted from the pulpmills while the oil refinery and pulpmills are the principle sources of sulphur dioxide. Other minor sources of TRS are also present in the Prince George bowl area which may influence a nearby monitoring station (ie. sewage treatment plant, residential heating units automobile emissions, etc.)

Particulate sources include the pulpmills, sawmill operations, dust from vehicle movement, slash burning, residential fireplaces, etc. Details of the various process capacities for the three pulpmills and the oil refinery for 1988 are shown in Tables C-1.1 and C-1.2 respectively. Periods of shutdown in 1988 are summarized in Appendix B.

TABLE C-1.1
Typical Operating Rate of Pulpmills in 1988

	Pulpmills		
Process Units	Intercontinental	Prince George	Northwood
Total Pulp, tpd	669	790	1,446
Digester, tpd	725	833	1,606
Dryers, tpd	669	790	1,446
Evaporators, tpd	725	833	1,606
Recovery Boilers, tpd	725	833	1,606
Lime Kilns, tpd	165 (as CaO)	205 (as CaO)	390 (as CaO)

TABLE C-1.2
1988 Husky Refinery
Typical Operating Rate

Process Units	Operating Rates		
	m^3/SD	B/SD	t/d
Crude Unit	1,603	10,084	-
Vacuum Distillation	-	-	-
Unifiner	1,252	7,877	-
Catalytic Cracking Unit	494	3,107	-
Reformer	236	1,484	-
Claus Sulphur Plant	-	-	-

TABLE C-1.3
Husky Refinery
Annual Average Stream Day Crude
Rate Compared to Maximum Stream Day Capacity

	Average Caily Crude Rate	Percent of Maximum Stream Stream Day Capacity
1981	1470.21 m^3	80.4 %
1982	1312.20 m^3	71.7 %
1983	1179.58 m^3	64.5 %
1984	1101.69 m^3	60.25 %
1985	1215.00 m3	66.5 %
1986	1308.00 m3	71.6 %
1987	1432.00 m3	78.3 %
1988	1603.00 m3	87.7 %

Maximum Plant Stream Day Capacity 1828 m^3/day

C-3 Typical Emission Rates from Industrial Complexes

The typical particulate discharge rates and gaseous emission rates from Prince George's major industrial complexes are summarized in Tables C-3.1 and C-3.2. Notes concerning data manipulation and sources are detailed below each table.

TABLE C-3.1
1988 Particulate Emission Rates from the Pulpmills in kg/min.
These rates represent normal operating conditions

Pulpmills	Recovery Boiler	Power Boiler	Lime Kiln and Dissolving Tank	Total
Intercon	1.75	0.715	0.188	2.653
P.G. Pulp	0.569	0.175	0.191	0.935
Northwood	1.45*	1.5**	0.3	5.9

Notes to Table C-3.1
1. All particulate emission data was provided by the pulpmills.
* Number 1 & 5 recovery boiler
** Number 2 & 4 power boiler

TABLE C-3.2
1988 Gasesous Emission Rates from Industrial Sources
in Prince George (kg/min)

	TRS as H2S			SO2			
	Recovery Boiler	Other Sources	Refinery Flare	Recovery Boiler	Refinery Flare	FCC Re-generator stack	Foul H2O stripper
Intercon	0.057	0.114	-	0.029	-	-	
P.G. Pulp	0.032	0.111	-	0.962	-	-	
Northwood	0.064	0.117	-	1.02	-	-	
Husky	-	0.015[1] 0.013[2] 0.002[3]	0.03	-	5.0	0.62[4]	.04[5]

Notes to Table C-3.2
1. These rates represent normal operating conditions
2. All emission data was provided by the industrial complexes

3. Husky notes:
1. Foul water stripper before vapour incineration revamp (Jan-Mar) "annual rate"
2. Fugitive emissions - includes compressor vents, process drains, storage tanks valves, flanges
3. Bio-oxidation pond- includes API/CPI separators
4. Other source SO2 from fluid catalytic cracker regenerator stack
5. Foul water stripper- via crude heater, start-up May 1/88, annual figure

4. Pulpmill "other sources"
This term refers to the following non-recovery boiler regulated stacks: digester system;multi-effect evaporators;condensate stripping; brownstock washing; black liquor oxidation systems; dissolving tanks; lime kilns; TRS incinerator. There are more emission sources at the mills that are not included in the above table such as effluent pond TRS emissions.

Appendix D - Monitoring Program Notes

D-1 Instrument Operating Hours

Although there are an average of 8760 hours in a year, ambient air analyzers require both scheduled and unscheduled maintenance to maintain the instrument's calibration and sensitivity to the appropriate standard. Therefore 75% of 8760 (6570) is acceptable as actual instrument operating hours. Hours are reduced by automated daily calibrations, manual weekly calibrations, bi-monthly audits, power failures, instrument malfunction anfd occasionly operator error.

In 1988, all of the continuous gaseous analyzers had an annual percentage of valid data greater than 75%.

D-2 Ambient Air Analyzer Instrument Drifts and Malfunctions

(i) Instrument Drifts

An ambient air analyzer is considered to be in calibration when the instrument drift, as determined formerly by an auditor from the Environmental Lab, is within + 15%. During and audit, occasionally, the instrument will respond incorrectly denoting a serious problem with the instrument's calibration.

In 1988, of the 3 audits that were performed during the year all of the Prince George continuous gaseous analyzers performed within + 15% except one, which was Foreman Flats during January.

The number of audits in 1988 were limited to 3 occasions from January to June. The Environmental Lab was privatized in August and unfortunately only one audit was performed during the remainder of the year. This audit was not considered usuable due to calibration equipment problems.

D-2 Ambient Air Analyzer Instrument Drifts and Malfunctions

(ii) Instrument Malfunctions

In 1988, only one station had monthly percent valid data less than 67%. In April, the Lakewood Philips continuous ambient analyzer broke down and did not respond to repairs. The analyzer was replaced with one from the Environmental Lab and the broken sent for repairs.

D-3 Instrument Changes

There were no instrument changes during 1988.

D-4 MIS Equipment Changes and Malfunctions

At all the stations, percent valid for the year was greater than 85%. One problem was noted during 1988 with a failure of the anemometer at PG Pulp in May.

APPENDIX E

MAPS

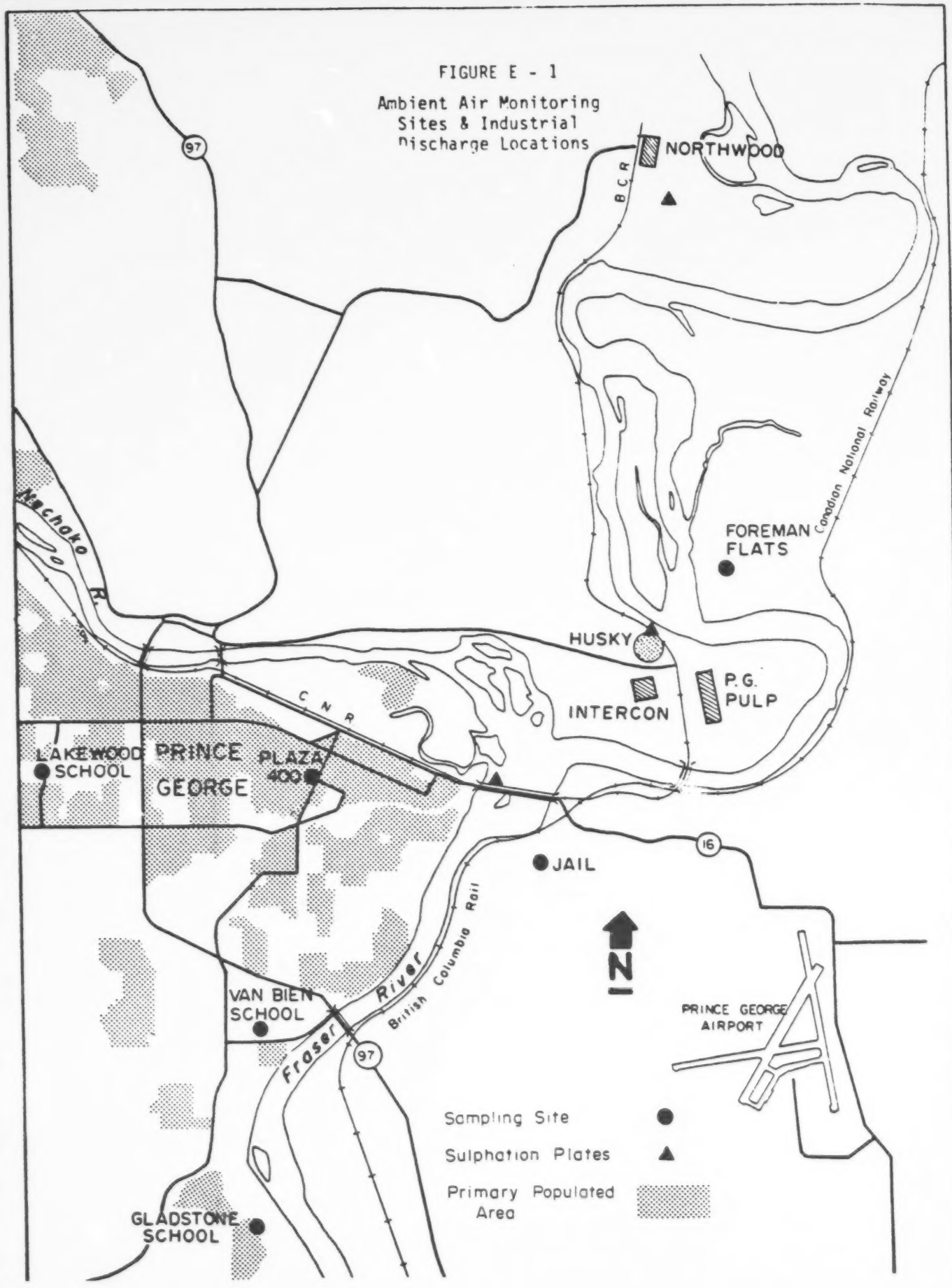


FIGURE E - 1
Ambient Air Monitoring
Sites & Industrial
Discharge Locations
NORTHWOOD
B C R
97
Canadian National Railway
FOREMAN
FLATS
Nechako R.
HUSKY
P.G.
PULP
INTERCON
C N R
LAKEWOOD
SCHOOL
PRINCE
GEORGE
PLAZA
400
16
JAIL
N
British Columbia Rail
River
Fraser
VAN BIEN
SCHOOL
PRINCE GEORGE
AIRPORT
97
Sampling Site
Sulphation Plates
Primary Populated
Area
GLADSTONE
SCHOOL

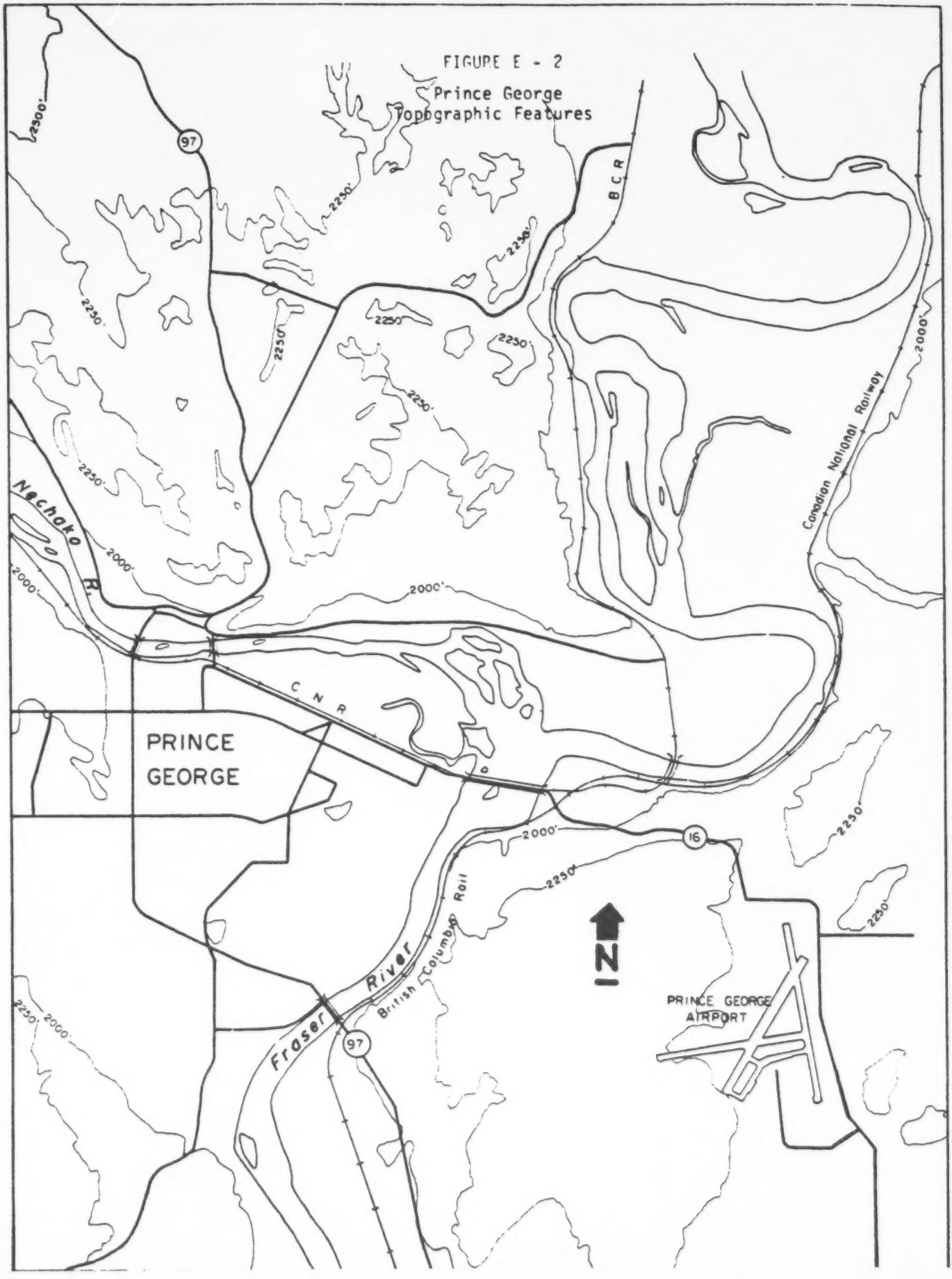


FIGURE E - 2
Prince George
Topographic Features
2300'
97
2250'
2000'
B.C.R.
Canadian National Railway
Nechako R.
C N R
PRINCE
GEORGE
16
N
Fraser River
British Columbia Rail
PRINCE GEORGE
AIRPORT